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CONTENTS

XXIV.—Phase Difference of Pressure Between the Windows the Essence of Sound Stimulation. Max F. Meyer, Ph. D., St. Louis	323
XXV.—Immobilization of the Round Window Membrane: A Further Experimental Study. Walter Hughson, M. D., and S. J. Crowe, M. D., Baltimore	332
XXVI.—The Relation of the Histopathology of Nasopharyngeal Neoplasms to Their Radio-Sensitivity. Joseph C. Beck, M. D., and M. Reese Guttman, M. D., Chicago	349
XXVII.—Underlying Factors in the Zinc Ionization Treatment of Middle Ear Infections. D. M. Lierle, M. D., and R. A. Sage, M. D., Iowa City	359
XXVIII.—Chondroma of the Larynx: Report of Six Cases. Frederick A. Figi, M. D., Rochester, Minn.	369
XXIX.—Allergy. William V. Mullin, M. D., Cleveland	387
XXX.—The Presence of Phagocytic Cells (Histiocytes) in Aural Mucosa. Ralph A. Fenton, M. D., in collaboration with Olof Larsell, Ph. D., Portland, Ore.	393
XXXI.—Empyema of Petrous Apex: Operation, Recovery. Ralph Almour, M. D., New York	405
XXXII.—Concerning the Normal Function of the Vestibular Apparatus. O. H. Mowrer, Ph. D., Baltimore	412
XXXIII.—Laryngitis and Tracheobronchitis in Children: Special Reference to Non-Diphtheritic Infections. T. R. Gittins, M. D., Sioux City	422
XXXIV.—Sinus Disease with Bloodstream Infection. John W. Carmack, M. D., Indianapolis	439
XXXV.—The Pathology of Carcinoma of the Larynx. Harrington B. Graham, M. D., San Francisco	453
XXXVI.—The Immediate Postoperative Technic Incident to a Caldwell-Luc Operation. W. P. Wherry, M. D., Omaha	460
XXXVII.—Sinus Thrombosis. Ernest M. Seydell, M. D., Wichita, Kansas	466
XXXVIII.—Sinusitis in Children. Warren B. Davis, M. D., Philadelphia	493
XXXIX.—Mastoiditis in Infants Associated with Gastro-Intestinal Symptoms. Harold R. Mulligan, M. D., Los Angeles	501

CONTENTS—Continued on Third Cover Page.

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XXIV.

PHASE DIFFERENCE OF PRESSURE BETWEEN THE
WINDOWS THE ESSENCE OF SOUND
STIMULATION.

MAX F. MEYER, PH. D.,*

ST. LOUIS.

Throwing out the animalistic conception of sound as if it were like a small, germlike parasite seeking entrance to the coveted sense organ, we must conclude as physicists that the normal stimulation of the human auditory organ is identical with a phase difference of the internal or external (it is physically the same concept) varying pressure at the one window (round or oval) in comparison with the varying pressure at the other window.† It is superfluous to add that we are speaking of a periodic physical variation, since the very term "phase" implies periodicity. The

*Research Professor of Psychology, University of Missouri.

†Compare Max F. Meyer, The Hydraulic Principles Governing the Function of the Cochlea, Jour. Gen'l Psy. I (2) 1928; pp. 239-265. It is totally irrelevant whether we think of this pressure as occurring on one side (that is, in the perilymph) or on the other side (that is, in the air of the middle ear) of a window. It is a fundamental principle of mathematical physics that the pressure on opposite sides of any point in a mathematical surface is always equal in magnitude, different only in sign relative to the surface. In the present paper, therefore, we do not compare the pressure in the lymph with the pressure in the air opposite each other. These pressures can not differ in magnitude. We are concerned with differences in magnitude of pressure between two surfaces, the two windows distant from each other, at a given instant.

work done in the cochlea results from the instantaneous pressure difference between the windows, which is now positive, now negative, now greater, now smaller. The stimulation of the hair cells results from, is a part of, the work done in the cochlea.

The pressure difference between the windows is itself preferably described mathematically in the form of the first derivative of a Fourier series.* The pressure difference thus described—this is of the greatest importance to remember—does not represent the varying external air pressure (density) which the vernacular language calls “a sound.” It is something purely relative existing at one window in comparison with the other window. The question “whether sound enters by the round window or by the oval window,” which has filled many pages in the otologic literature, is fictitious, therefore mystifying, and should never be asked. Physiologically speaking, sound does not enter the cochlea at all.

Restated in more ordinary terms, without reference to a mathematical equation, what we have just stated means that the pressure difference between the windows is greatest (but without reference to the sign, which is alternately plus and minus) at the instant when the external air density is changing most rapidly; and it is zero at the instant when the external air density happens to be either at its maximum or at its minimum. On the other hand, the pressure difference between the windows is greatest when the shaken skull moves most rapidly; and it is zero when the shaken skull is at the moment of reversing its direction.

Let us consider this further. It is pure mechanics. There are two quite independent causes of a pressure difference between the windows. One is popularly called “air conduction”; the unfortunate and undeserved popular name of the second is “bone conduction.” If these terms are to stand for physical concepts, they are not very well chosen. Proof (one of many instances):

*The series of trigonometrical functions which describes the pressure difference between the windows between two moments of time, t_0 and t_1 , is the first derivative of the standard Fourier series and has this form:

$$p = f'(t) = (-a_1 \sin t + b_1 \cos t) + 2(-a_2 \sin 2t + b_2 \cos 2t) + 3(-a_3 \sin 3t + b_3 \cos 3t) + \dots$$

This formula may seem formidable to one not accustomed to mathematics. It is printed here for the convenience of some readers and still more for this reason: the essential fact, to which we return at the end of this article, is that the admission that a physical sound is preferably described by a Fourier series does not imply any belief that the ear is an harmonic analyzer consisting of resonators or sound filters.

There are in the otologic literature tales like these: "The promontory throws a sound shadow of the sound rays on the round window." Now, there are sound shadows in this world—but not here. You may observe them in a hilly country when, a mile or so away, a locomotive disappears behind a hill and its puffing sounds are lost, too, until it reappears to the eye (although you have to wait for the slower sound propagation). A mound, a promontory, must have a magnitude of many times the wave length of the ray before it can throw a shadow. Likewise, neither the air in the middle ear nor the bone in the head should be said to conduct a sound wave, while the wave has a length many times that of the conductor. No sound wave ever races around in the cochlea or even in the head. Let us see if we cannot formulate the problem in a more rational, logical way.

The cochlea is a tiny vessel, filled with a liquid like very thin glue, and possessing two flexible windows which separate the inner fluid, a liquid, from the outer fluid, a gas. "Flexibility" is here taken in the, physically quite sufficient, relative sense, which means only that the bony parts of the cochlea are very much less flexible than the "panes" of these windows. There are two conditions under which in such a vessel the window panes must "bulge." Of course, they bulge simultaneously always in the opposite sense, since (in its relativity) the concept of "compressibility" is not freely applicable to the tiny drops of liquid composing the fluid content of the vessel; and motion of this liquid is unavoidable. The liquid must move: (1) whenever for some reason on the outside of the two windows the fluid (in this case a gas, common air) is not kept under constantly equal pressure—that is, when there is an instantaneous pressure difference from one to the other window, as is usual in our noisy world; (2) whenever the vessel is shaken,* provided that one of the window panes carries a greater "load" than the other one.

*No physicist can make here a distinction whether the shaking results from (1) the skull obstructing the propagation of an air wave or (2) the skull being in contact with a vibrating solid body, say, the otologist's tuning fork. The former is the same "bone conduction" (unfortunately so called) as the latter, if the otologist insists on preserving that term merely because it has become second nature to his thinking. Johannes Müller, long ago, raised the same objections to the distinction of air conduction and bone conduction which we are raising here: it is impossible to separate one from the other.

Since to most biologists discussions of mechanics seem a little abstract, let us still further elaborate these two causal conditions of "pane bulging combined with liquid swinging between these panes." With respect to the first condition, it is perhaps enough to say that it would be a clear miracle if the liquid did not move between the different air pressures in the direction of the sign of the difference.

To exemplify the second condition, make the following experiments. Take a piece of tubing (copper, glass, or what not). If you wish, bend the ends sidewise. Fill with water. Close with most loosely fitting, really sliding, corks. Now give the tube a violent jerk lengthwise and see if the cork on one of the ends will not come out. The inertia of the water does it. It is really the inversion of what happens when you close your bathroom faucet too quickly and the tube pounds the floor or wall.

But if you find the center of gravity of your water-filled tube, and draw a line in space through it and a point midway between the openings, and now jerk along this line, nothing is likely to happen. How has Nature protected us against this "insensibility" of our auditory sense organ? In two ways. First, by giving us two ears, and by not placing them so that the "critical" line above referred to in one ear is parallel to that in the other. Either ear can thus compensate for the relative insufficiency of the other. Secondly, by loading the oval window pane with a heavy weight made up of the stirrup, the hammer, the anvil, the tympanum and the muscles attached to these bodies, whereas the round window is quite free from any extrinsic load. A load by the laws of mechanics causes a "lag"—that is, a phase difference.

If you want to demonstrate an analogous lag by a simple physical experiment, try this: Take a chemical balance with very light pans and a long scale indicator. Place a gram gently on one side and observe the velocity with which the indicator moves over the scale. Now first load the instrument, for example, by placing a hundred grams on each pan; then as before place a gram gently on one of the pans and observe the lessened velocity, the hesitation, with which the indicator now moves over the scale. Of course there is a lag. And likewise there is a lag, but a simulta-

neous lag, a phase difference of pressure, between our two windows. This is pure and common mechanics.

It is unfortunate that this phase difference is called by the otologists "bone conduction" and the other phase difference "air conduction." It is true that on many occasions this terminology is harmless; but on other occasions it is confusing, misleading the practitioner. Sound ought not to be spoken of as if it were like a flea or other parasite, seeking its way in the cracks of the body, being baffled here and there, finally getting there. Sound ought not to be spoken of as a mechanical configuration occurring within the various physiologic bodies, solids, liquids and gases, which constitute the animal. One (that is, a physicist) can justify that somehow; but to the biologist it is confusing, because the latter has to think of the anatomic units. These bodies are too small to be considered in such a way, as if they could contain, inclose, be penetrated by, a sound. So far as the otologist is concerned, the sound is not in them. They are in the sound, in the sound wave. The latter is the clearer conception.*

Now let us make a few observations of an otologic nature concerning the efficiency of the phase difference at the two windows for the liquid's motion between the two windows in the cochlea. When the phase difference results from the unsymmetrical application of loads extrinsically to the oval and round windows, this lack of symmetry may not always be great enough if the head is shaken. Now suppose even total absence of the ossicles. How could the phase difference be artificially increased? More than twenty years ago Bárány showed how.* "The middle ear cavity of the patient has become totally epidermic and the tube is closed. I put a drop of mercury in as an obstruction, a retarding resistance, a load. When the drop covers the niche of the round window, hearing is improved. But it is essential that the oval (the other) window remain free." If this is not a simple physical method of increasing the velocity lag and there-

*The reverse is true for light and the eye. The light ray does seek entrance to a rod or cone; and a rod or cone of the retina is never within a light ray, for the latter is too narrow for that. It is very dangerous to carry analogies from one sense organ to another.

†*Monatsschrift für Ohrenheilkunde und Laryngo-Rhinologie*, 44, 1910, p. 550.

with the phase difference of pressure between the two windows, what else could it be? But Nature did something analogous for air conduction long before Bárány did it artificially for a patient dependent on bone conduction.

A curved line drawn from the center of the round window out through the meatus is but slightly longer than a similar route from the oval window out through the meatus. Therefore the phase difference is not great, and would be especially small for tones of very low frequency, say, from 100 cycles down. How could Nature help these lower tones? That is, how could she increase the phase difference for air conduction? By utilizing an existing protective membrane, originally just serving the animal to keep the windows moist and free from dust, for a secondary purpose. By establishing a solid connection between the tympanum and the oval window, the phase difference for air conduction amounts now to as much as it would if the oval window were placed in the meatus where the tympanum is, with the round window left in its original location.* Hearing is greatly improved by our possession of this shortening of the one of the two routes of the air density to the cochlea, this increase of the phase difference; and it is improved particularly for the very lowest tones. Physics and otology are in perfect harmony.

Let us return to bone conduction. Things even lighter than mercury do the trick. Mere secretion, caused by boric acid, in a patient who has suffered a radical operation, may improve the hearing when, after five minutes, it has covered, weighted, the round window and has thus increased the phase difference. But in this case the phase difference is not increased by lengthening the route of the air density change through the meatus to the round window, but by loading the membrane of the round window, as with Bárány's mercury drop. That is, it is the very opposite (but as effective) as the loading of the oval window in the normal ear by the ossicle chain for bone conduction.

No matter whether it is the oval or the round window—the loading of either is physically the second case, where shaking

*Whether this solid connecting link is jointed (as in the mammals) or a simple rod (as in the birds) is of very small mechanical consequence. Its importance consists in its solidity, relative incompressibility, compared with air.

of the whole head is to be considered as the main cause of the swinging of the liquid within the cochlea from one window toward the other.

Bárány in his quoted report emphasizes (p. 551) that by loading the normal tympanum with mercury he could lengthen bone conduction to make it equal to air conduction. We cannot expect this otherwise, since the effectiveness for hearing of shaking the whole head depends on loading either one of the windows to cause a lag, a phase difference of the window pane. Bárány then adds the physically interesting remark: "Bone conduction and air conduction are by no means generally hostile to each other. An improved air conduction does not logically or actually imply an abbreviation of bone conduction." This supports our contention that bone conduction and air conduction are inseparable sources of stimulation, and that the essence of stimulation is unitary, is mere phase difference between the windows.

Physically the otologist should always consider what he is doing to the phase difference of the instantaneous pressure between the two windows,—during a periodic pressure change, no matter where the latter originates, either (1) in the air density of the ear cavity or (2) in the shaking of the whole head of which the cochlea is a part.*

What goes on further in the cochlea, while the liquid swings between the windows, has been discussed elsewhere and is a problem beyond the limits of the present article. It is unbelievable—let us say this, nevertheless—that the phragma, inclusive of the ductus cochlearis, which separates the two scalæ, could serve as a series of sound filters (formerly called resonators). It is unbelievable because one cannot see anatomically any "capacities," which means in physical terminology bodies capable of potential energy. There are neither stiff bodies nor bodies strained by a permanent pull within the cochlea, to serve as capacities—facts which the biologists are apt to overlook and the physicists are apt to be ignorant of. The physical requirement for constituting a

*In the latter case, in the normal ear, closing the meatus with a finger greatly increases (in accordance with mechanical theory) the impedance of the solid chain from the oval window to the tympanic membrane, and minutely the impedance of the round window. It acts like a brake on the oval window. Thus it increases the load.

sound filter is a capacity and a load combined. There are plenty of loads in the cochlea. The columns of liquid could serve magnificently as such loads and have been claimed as such by contemporary theorizers. But anatomically there are no capacities whatsoever. There is nothing stiff that could plausibly serve. There is nothing preparatorily stretched. Resonators or sound filters are therefore verbal fictions.

How, nevertheless, the cochlea can serve as an analyzer by its simple anatomic properties made hydraulically effective, I have shown in my article quoted above, and elsewhere. I must refer to that existing literature. My object in view here was merely to point out that either kind of phase difference between the windows is the essence of sound stimulation, and that keeping this in mind is likely to be helpful to the otologist who wants to increase the susceptibility of his patient's ear to stimulation.

The otologist is likely to desire an answer to a further question. Granted that the phase difference of pressure between the two windows is the essence of auditory stimulation, how will this be affected by gradually progressing ossification of both window panes or of one of them? It is clear that a very mild ossification of the oval window (and it is there where ossification is likely to occur first, for general biologic reasons probably) would be a slight addition to its load and an advantage in case the stimulation comes by way of shaking the skull; it would be no advantage to the stimulation depending directly on the phase difference in the air of the middle ear. Further advances in ossification, however, would interfere with the swinging motion of the lymph in the cochlea between the windows and thus reduce the sensitivity of the organ, no matter which was the origin of the stimulation.

There is a possibility that the hair cells in the cochlea, in case of advanced ossification of the windows without any injury to the nerve, are stimulated in a very primitive way, comparable to the stimulation of the (anyway windowless) vestibular organs. I have discussed this possibility in my "Psychology of the Other One" (pp. 294-296, 302). This stimulation, being primitive, would be very weak; and further, analysis of a compound sound would

be impossible then. But simultaneous analysis by one ear alone is probably impossible in all animals with very short cochlea; and yet such animals, the birds especially, undoubtedly profit from their ability to hear. Why should not hard-of-hearing human beings profit likewise? However, this whole possibility of a primitive functioning of the mammalian auditory organ is no more than a theoretical deduction. Observed facts, anatomic, physiologic, psychologic, concerning this matter are not known at the present time.

IMMOBILIZATION OF THE ROUND WINDOW MEMBRANE: A FURTHER EXPERIMENTAL STUDY.*

WALTER HUGHSON, M. D., AND S. J. CROWE, M. D.,

BALTIMORE.

In previous reports^{1 2} the effect of plugging the round window of the cat's ear with cotton was detailed. Twenty animals were used specifically for the purpose of this particular investigation, and similar observations were made on many more in which the procedure was incidental to some other type of experiment. Using the Wever and Bray³ effect as a means of testing the transmission of different types of sound stimuli through the cat's ear it was shown that plugging the round window in this manner invariably resulted in an increased intensity of spoken words and tones from 125 d.v. to 4,000 d.v. During the past few months this phenomenon has been demonstrated repeatedly under conditions of much greater scientific accuracy not only with cotton plugs but in animals in which periosteal grafts had been placed in the round window under strict surgical technic and the animals tested at varying intervals after the operation. After surmounting various technical difficulties in both operative and experimental procedures the results obtained confirm in every way the conclusions previously reported.

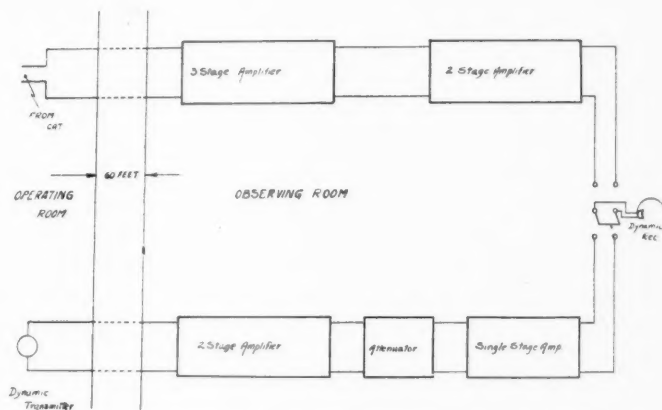
That the investigation might be established on a constant physiologic basis and the tests permit of graphic representation the following experimental technic has finally been evolved. Much of the technical apparatus has been obtained through the courtesy and co-operation of Dr. Harvey Fletcher. In addition to the amplifying apparatus connected to an electrode on the cat's auditory nerves and a third electrode grounded in the muscles of the

*Presented before the American Association of Anatomists, March 25, 1932.

From the Otological Research Laboratory and the Surgical Hunterian Laboratory, Johns Hopkins University School of Medicine.

neck, a dynamic microphone connected with a second amplifier has been installed. All sound stimuli are led simultaneously to the cat's ear and to the microphone (see diagram). In the observing room, situated at the opposite end of the building, an attenuation box is placed in a second amplifier. Using a telephone receiver, the observer can listen at will to the sound transmitted through the cat's ear or through the microphone by simply turning a two-way switch. The intensity of tone transmitted through the microphone system may be changed by introducing units of attenuation and the intensity of these tones then brought to a "balance" with the tones transmitted through the cat's ear. The units of attenuation are decibels and the value of any given tone transmitted is expressed, therefore, in the number of decibels required to produce a true balance between the two systems.

The sources of sound include a phonograph record in which a standard articulation sentence is repeated over and over, and for tones an oscillator is used. The tones arbitrarily chosen for use in the tests are 250, 500, 1,000, 2,000, 4,000 and 8,000 d.v. The detailed and technical description of this entire apparatus will shortly appear.



1. Diagram of amplifying and measuring apparatus. For details of manipulation see text.

To evaluate properly the effect of different experimental procedures, some normal standard had, of course, to be established. At first it was thought necessary to determine in a large series of experimental animals—cats have been used exclusively—normal transmission for the constant conditions under which the experiments are conducted. Such a determination would have involved a very long drawn out study and the idea was abandoned. It has been definitely demonstrated, however, that the transmission of sounds through the opposite ears of the cat is practically identical provided the two ears are normal. (Chart I.) A normal attenuation setting is obtained as a control for each ear. Thereafter, all differences in the attenuation setting are due

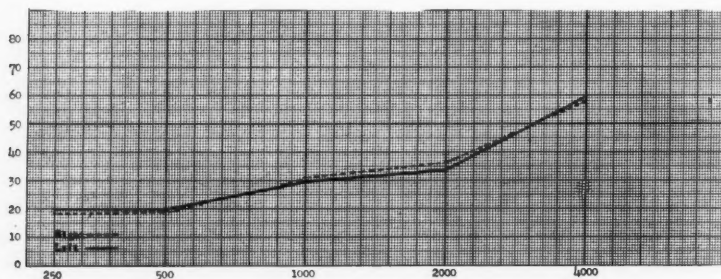


Chart I. Experiment 95. January 6, 1932. Control test for normal right and left ears showing that transmission in the two ears is practically identical.

to experimental procedures on one or the other ear. The most common lesion is a middle ear infection. On the basis of the above findings it was thought proper to assume that in normal cats the transmission in the two ears was identical and that in any given animal one ear might be used to control the effect of experimental procedures carried out on the opposite ear. The accuracy of this assumption has been borne out in a series of well over 100 experiments performed for a variety of purposes.

In all sacrifice experiments the general experimental technic is as follows: The cats are anesthetized with ether, a tracheal tube inserted and the anesthetic maintained by connecting the tracheal tube with a Woulfe bottle through which compressed air

passes over the ether. Through a midline incision in the neck the mastoid bullæ on both sides are exposed and either opened immediately or later. The occipital region is then freed of the temporal muscles and a small trephine opening made on both sides, the dura opened and a small silver electrode placed on each auditory nerve. The accuracy of the placement of the electrodes is determined by definite stimulation of the facial nerve. The electrodes are connected with a switch which permits introducing either ear into the circuit at will. Very slight changes in the position of the electrodes have little, if any, effect on the intensity of transmission. This fact has been demonstrated repeatedly. The electrodes are then firmly fixed in position, the animal turned upon its back and the earpieces of an ordinary clinical stethoscope placed in the two ears. The bell of the stethoscope can then be inserted in a rubber tube leading from a phonograph or in a similar tube from the oscillator. No change is made in the animal's position during the remainder of the experiment.

Tests are immediately made with the spoken voice, the phonograph voice record and the tones to determine the transmission through the two ears. If the values are practically identical on both sides for all tones some experimental procedure is then carried out on one ear. With this accurate system of measurement and the constant experimental conditions outlined above, the effect of plugging the round window niche with cotton has been confirmed in a large series of animals. When the cotton is properly placed a resulting increased intensity of the sound transmitted through the ear is always noted. The average improvement of intensity in twelve such experiments is shown in Chart II. The control ear is indicated by the straight line and the improvement for each tone indicated by corresponding points on the dotted line. As stated above, this difference is measured in decibels of attenuation.

During the past year an effort has been made to determine the late effect of immobilization of the round window membrane. Operations, therefore, were performed under strict aseptic technic for the purpose of permanently immobilizing the round window membrane. Considerable difficulty was experienced in the successful performance of this procedure, chief of which was the fre-

quent infection of the ear following operation. Despite the greatest precaution, infection of the ear is extremely common in operations on cats. It is thought, though not definitely demonstrated, that operation may light up in some way a low grade infection already present in the middle ear. In all, thirty-one such operations were performed and the animals subsequently tested. A variety of methods was employed before an entirely satisfactory one was developed and before the actual operative technic could be considered reliable. Fascia grafts of various sizes, bone chips alone and bone chips held in place with bits of fascia were used with generally unsatisfactory results. The method which has finally proved successful was the placement of a small periosteal

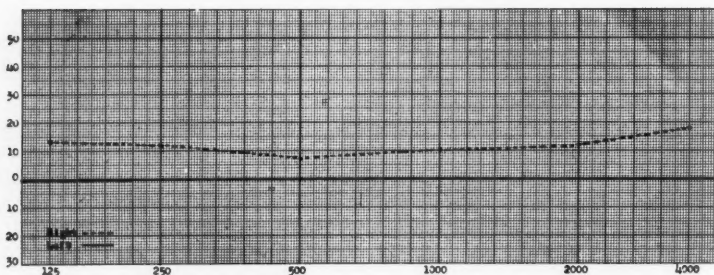


Chart II. Average of values in twelve animals in which cotton was placed in round window of right ear.

graft in the round window niche. The mucous membrane on the border of the niche is wiped carefully with cotton, the membrane itself wiped with the greatest precaution, the graft put in place and held for a few moments with a slight pressure and any excess serum is thus absorbed by the cotton pledget. Should too great pressure be exerted the round window membrane will be torn and possibly the basal osseous spiral lamina fractured. In either case impairment in transmission rather than improvement will result.

Animals operated upon in this manner are then kept for varying lengths of time before testing. When tested the unoperated ear is again assumed to be normal and is used as the control. The results of all tests are carefully checked by gross examination fol-

lowing sacrifice and by microscopic study of the ears. In a small series of animals improvement in the intensity of transmission of the operated ear over the unoperated one has been definitely established. Not only has the difference in the two ears been actually demonstrated but an improvement over the intensity expected in normal cats been found. Animals have been tested at intervals of from two days to seven weeks following the original operation. In six consecutive experiments the improvement has been clearly shown. The complete protocol of such an experiment follows:

EXPERIMENT NO. 65.

December 7, 1931. Ether started 4 p. m.; ended 5:10 p. m.

Cat No. 41: Large, gray and white; in good condition.

Operation: Periosteum from bulla packed into round window niche, right. Round window membrane punctured with a needle.

Anesthesia: Intratracheal ether.

Procedure: The usual incision was made and the bulla opened, exposing the right round window. The ear was perfectly normal; no sign of infection. A small amount of periosteum was removed from the bulla and packed into the niche of the round window after the membrane had been punctured with a needle. It seemed to be packed tightly into the niche. There was a small amount of bleeding when the membrane was punctured. Wound was closed with black silk as usual. Animal in good condition at end of operation.

December 9, 1931: Animal in good condition. No evidence of labyrinth disturbance.

December 11, 1931: No apparent change in animal's condition.

December 12, 1931: Neck wound full of pus, but probably just under the skin. No vestibular symptoms.

December 14, 1931: No change.

December 15, 1931: Animal in good condition. Infection clearing up.

December 24, 1931: Neck infection cleared up.

January 1, 1932: Animal in good condition.

January 26, 1932. Ether started, 2:15 p. m.; animal sacrificed, 4:30 p. m.

Anesthesia: Intratracheal ether.

Procedure: Animal prepared for test in usual manner. Both bullae were opened and found to be perfectly free from any signs of infection.

Results: Transmission was good on both sides but very much better on the right, operated side. The voice record balanced at 24 decibels on the right side and 44 decibels on the left side. In the test with the tones there was also an average difference of about 20 decibels between the two sides.

Autopsy: The mastoid bulla when opened was perfectly clear. With careful gross examination the round window was apparently closed over and the graft, which at operation was packed in tightly, was completely covered with mucous membrane. In fact, it was difficult to be entirely sure of the exact position of the

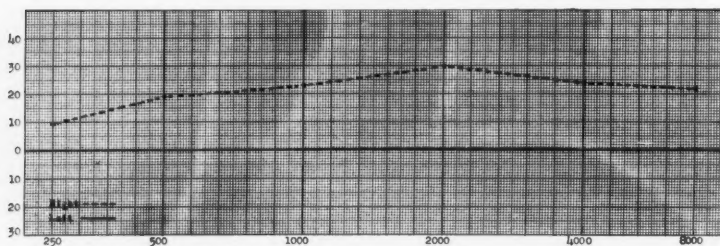


Chart III. Experiment 65. Operation: December 7, 1931, periosteal graft right round window. Tested: Interval of seven weeks.

round window. The graft had not extended outside of the round window at all as in many of the other specimen sections. Also it was possible to see through into the middle ear, which was also apparently clear.

In this experiment approximately seven weeks elapsed between operation and final test of sound transmission. Though a wound infection occurred, examination showed that there was no infection of the middle ear on either side. The animal was in excellent condition at the time of the final test. Chart III illustrates graphically the difference in intensity between the two ears. The method of charting indicates the difference between the right or

operated ear—dotted line—and the unoperated ear, unbroken line. The level of the dotted line is obtained by using the number of decibels by which each tone in the operated and control ear differs in intensity. The unoperated ear, therefore, is regarded as the base line, and the value for each tone on the dotted line indicates improvement. The most marked increase occurred between 500 and 4,000 d.v. In Fig. 1 is shown a photomicrograph of the round window region—the graft somewhat shrunken but well within the niche and covered over with a hyperplastic mucous

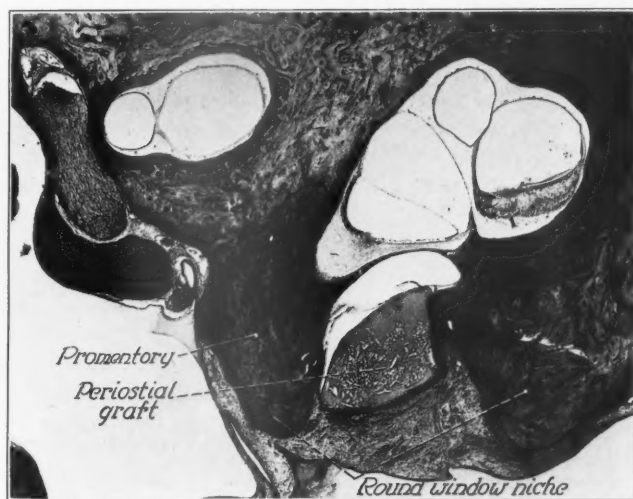


Fig. 1. Periosteal graft in round window seven weeks after operation. Animal tested in Chart III.

membrane. In this section the graft does not appear in direct contact with the round window membrane but the intervening space was apparently filled with fluid. The resultant effect, at any rate, corresponds in every way to pressure with cotton upon the round window membrane. In the protocol it will be noted that the round window membrane was punctured. At the time this particular procedure was being carried out to determine whether or not the graft would adhere more firmly to the membrane. The

other experiments reported indicate that nothing whatever is gained by opening the membrane. As a matter of fact, the chance of a labyrinthitis developing after this is done involves an unwarranted risk.

Another protocol of an animal tested two days after operation is the following:

EXPERIMENT NO. 108

January 27, 1932. Ether started 2:30 p. m.; ended 3:45 p. m.

Cat No. 61: Medium sized, grey; in good condition.

Operation: Periosteal graft packed tightly into round window, right.

Anesthesia: Intratracheal ether.

Procedure: The usual incision was made and the bulla opened, exposing the right round window. The ear was perfectly normal, no sign of infection. A small amount of periosteum was removed from the bulla and packed tightly into the round window niche, after the membrane had been rubbed with cotton. Wound was closed with fine black silk as usual. Animal in good condition at end of operation.

January 29, 1932. Ether started 9:40 a. m.; animal sacrificed 12:00 noon.

Note: Animal had developed distemper.

Anesthesia: Intratracheal ether.

Procedure: Animal prepared for test in usual manner. Neither bulla was opened before tests were made.

Results: Transmission of voice on the right, operated side, was excellent but was rather poor on the unoperated side. The voice record was 21 decibels on the right side and 60 decibels on the left side. The difference in the test with the tones was approximately 30 decibels.

Autopsy: The right ear was opened, and although there was no signs whatever of infection there was a clot in the mastoid bulla extending down partially over the graft which was in the same position as at the time of operation. The middle ear was opened and found to contain a considerable amount of serum. This covered over the tensor tympani muscle and apparently completely filled the attic, a fact which makes the transmission re-

corded even more remarkable. The left bulla and middle ear were perfectly normal.

As indicated in the notes, there was marked difference in the transmission of the voice record on the two sides and an even more striking difference for tone transmission (Chart IV.) As is shown, however, practically the same intensity values were obtained for the two ears at 8,000 d.v. Fig. 2, a photomicrograph of the round window region of the operated ear of this animal, shows the graft completely filling the round window niche and firmly in place against the membrane. It can also be seen that the membrane is intact and the basal osseous spiral lamina undamaged.

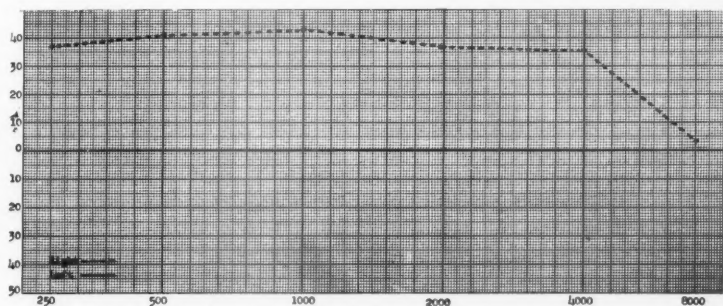


Chart IV. Experiment 108. Operation: January 27, 1932, periosteal graft right round window. Tested: Interval of two days.

Chart V is the result obtained in an animal tested ten days after operation. Here the difference between the two ears is not so striking, but the transmission on the unoperated side was unusually good, making the improvement of the operated ear even more remarkable. The photomicrograph, Fig. 3, shows the graft completely filling the round window niche, though again a space exists between its inner surface and the membrane. The graft extends out somewhat into the mastoid bulla, but under higher magnification there can be seen definite union with the mucous membrane along the border of the round window niche. Indeed, this is perfectly apparent in the photomicrograph. In Chart VI

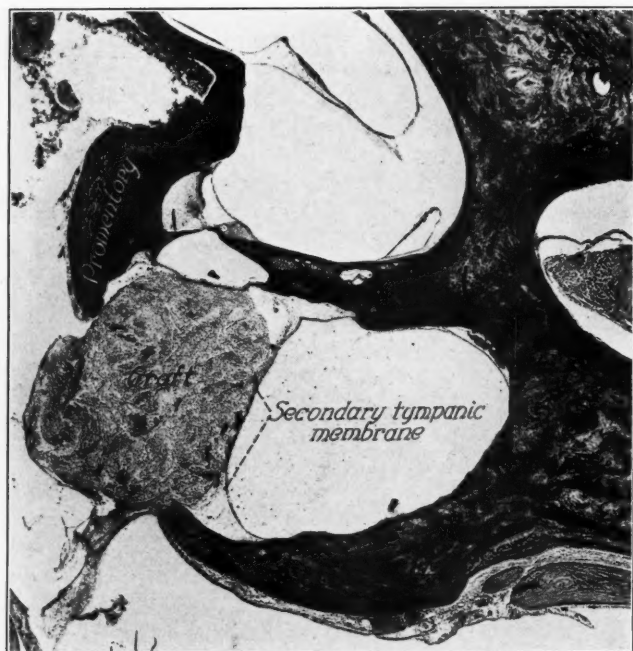


Fig. 2. Periosteal graft in round window two days after operation.
Animal tested in Chart IV.

appears an extreme difference. The protocol of the experiment follows:

EXPERIMENT NO. 96.

January 6, 1932. Ether started, 3:00 p. m.; ended, 4:10 p. m.

Cat No. 60: Medium sized, tiger and white; in good condition.

Operation: Fascia graft packed into round window niche, right; middle ear opened.

Anesthesia: Intratracheal ether.

Procedure: The usual incision was made and the right bulla opened, exposing the round window. The middle ear was then opened and there was no sign of infection. A small amount of

blood which had collected in the bulla and the middle ear was cleaned out carefully and a fascia graft packed tightly into the round window niche. Wound was closed with fine black silk. Animal in good condition at end of operation.

January 7, 1932: No vestibular symptoms. Animal in good condition.

January 9, 1932: Slight neck infection. Neck opened.

January 13, 1932: Neck infection cleared up.

February 2, 1932. Ether started, 9:40 a. m.; animal sacrificed 12:30 p. m.

Anesthesia: Intratracheal ether.

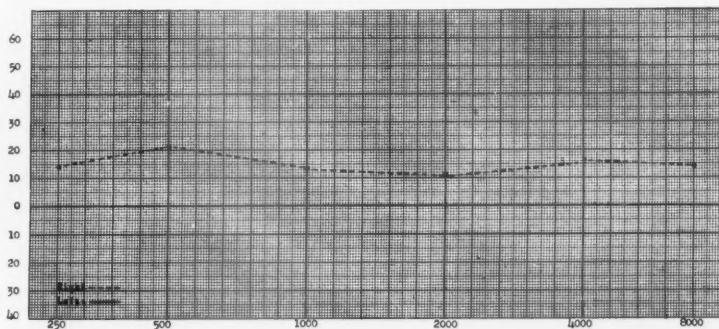


Chart V. Experiment 111. Operation: February 2, 1932, periosteal graft right round window. Tested: Interval of ten days.

Procedure: Animal prepared for test in usual manner, electrodes being placed on both auditory nerves. Both bullae were opened and found to be free from infection.

Results: Transmission was excellent on the right side but rather poor on the left side. The voice record was 25 decibels on the right side and 43 decibels on the left side. There was no question that the right side was much better than normal, but for some reason which could not be explained the left side seemed to be poorer than normal.

Autopsy: The right ear, when opened, was found to be perfectly clear, not only in the bulla but also the middle ear. The

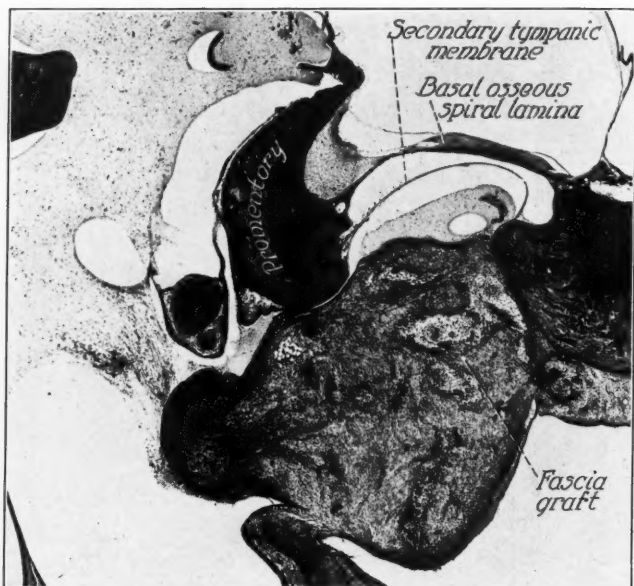


Fig. 3. Periosteal graft in round window ten days after operation.
Animal tested in Chart V.

round window region was entirely filled up with the fascia graft, which had increased greatly in size and had apparently become adherent to all the surrounding parts of the bulla. This was in very marked contrast to the periosteal grafts, which apparently contract well down into the round window itself. The left ear was apparently normal and no adequate explanation could be found for the poor transmission on this control side. This must be assumed to be simply an ear in which conduction was poorer than normal.

It will be noted that in this experiment a fascia graft was used and, although effective, the graft (Fig. 4) has spread widely from the borders of the niche into the cavity of the bulla. There is also apparent a certain amount of old blood between the graft and the membrane. Though transmission on the left side was extreme-

ly poor, that on the right was unusually good for the tones 250 to 2,000 d.v., certainly 15 to 20 decibels better than normal. This animal was tested one month after operation.

DISCUSSION.

As detailed above, an exact and constant experimental method has been developed for modifying, either in a favorable or unfavorable manner, the intensity of words and tones transmitted by the cat's ear. Investigation of the physiology of the ear in this animal has now extended over a period of more than a year. Over two hundred actual experiments have been performed. In

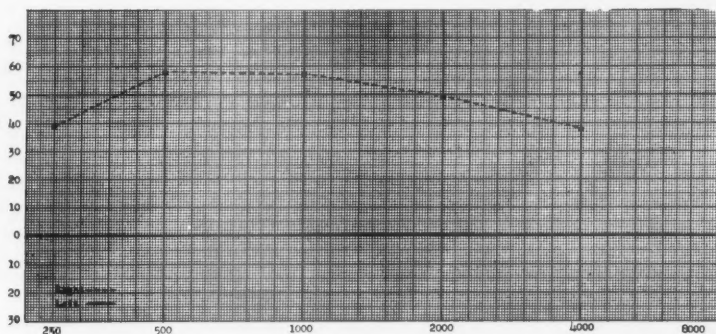


Chart VI. Experiment 96. Operation: January 6, 1932, fascia graft right round window. Tested: Interval of four weeks.

all these experiments the Wever and Bray phenomenon has been used as the method of measuring the efficiency of the auditory apparatus in transmitting different types of sound. Though not directly concerned with the neurophysiologic aspect of the phenomenon it is felt that much of the data obtained in this investigation lends strong support to the views of these investigators. Certainly the method offers an ideal means for an objective study of the auditory end organ. In all experiments it has proved accurate and reliable. Great pains have been taken to eliminate every possible source of error resulting from electrical disturbance due to magnetic fields, etc., and at the end of every experiment tests

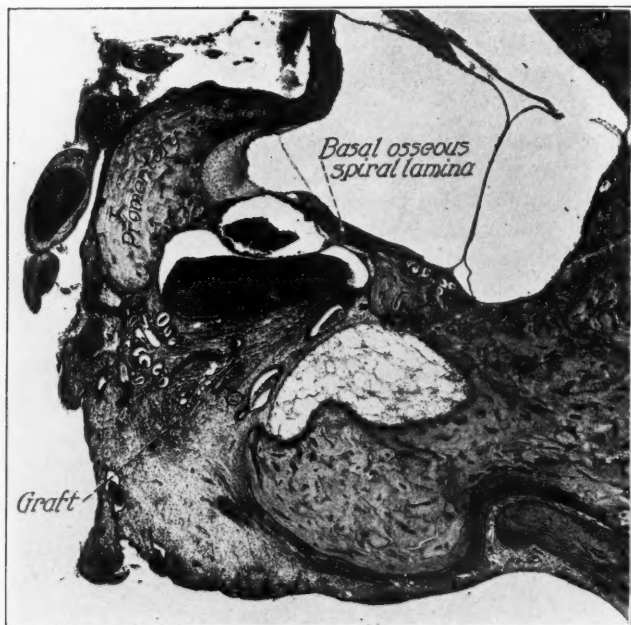


Fig. 4. Fascia graft in round window twenty-seven days after operation. Animal tested in Chart VI.

are made to check such possible sources of error. The fact that transmission can be eliminated from one ear by a great variety of procedures while the other remains perfectly normal is convincing evidence that the auditory apparatus is essential to the actual demonstration of the phenomenon. Furthermore, other investigators⁴ have definitely shown that the auditory pathways of the brain are directly concerned in the conduction of the impulses set up in the ear itself.

The method of control used and described above might possibly be open to criticism were it not that its accuracy has been demonstrated repeatedly. The technic of placing the electrodes on the auditory nerves has been so standardized that no marked differ-

ence in transmission is ever observed which might be attributed to this particular factor. Where differences are noted some gross or microscopic lesion in the ear can always be demonstrated or the animal may simply have conduction inherently poorer than normal. It is felt, therefore, that the improvement in sound transmission produced by immobilization of the round window membrane with periosteal grafts is a true increase in intensity over that of the normal ear.

In the preliminary report of this investigation the following statement was made: "The secondary tympanic membrane apparently acts as a safety valve to protect the structures of the inner ear and owing to its mobility absorbs a large percentage of the sound impulses that reach the cochlea." There appears no reason for changing this view at the present time. Obviously pressure upon the membrane cannot materially affect intralabyrinthine pressure more than momentarily. Indeed, there is already experimental evidence at hand indicating that greatly increased intralabyrinthine pressure has no effect whatever upon the transmission of sound. There remains then, no other explanation of the phenomenon but that of immobilization or fixation of the round window membrane itself. What the effect of this fixation might be upon sound impulses of explosive intensity has not been determined but certainly no deleterious effect has been noted in animals which are maintained under average normal conditions.

CONCLUSION.

Using an accurate method of measuring the intensity of sound impulses transmitted through the cat's ear, and with a standardized experimental technic the increased intensity produced by packing the round window niche with pledgets of cotton, already reported, has been amply and repeatedly confirmed.

Furthermore, an operative procedure has been developed whereby the round window membrane of a cat's ear can be immobilized with a periosteal graft. The result of this immobilization is a great increase in the intensity of spoken voice and tones transmitted through the operated ear. This effect has been noted in a series of animals tested at intervals of from two days to seven weeks following the original operation.

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XXVI.

THE RELATION OF THE HISTOPATHOLOGY OF NASOPHARYNGEAL NEOPLASMS TO THEIR RADIO-SENSITIVITY.*

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I. LYMPHEPITHELIOMA AND TRANSITIONAL CELL CARCINOMA.

It has been more or less generally assumed by the profession at large that our knowledge concerning the clinical course and the pathologic manifestations of carcinoma of the nasopharynx has been more or less complete. Yet the light of recent experience with the use of irradiation, by X-ray and radium, has shown that there is a wide degree of difference in the response of apparently similar neoplasms to radiotherapy. It has been through the industry of the radium therapist interested in histopathology that several new clinical entities have been developed and removed from the general category of malignant epithelial neoplasms. In fact, a new branch of histopathology, namely, radio-histology, has been developed, which embraces the study of changes brought about by irradiation in normal and tumor tissue and their classifications. In the course of investigation it was but natural that some attempt should be made to correlate the histologic picture of neoplasm to its response to therapy. The radio-histologist has gone further and studied the histo-genesis of the various neoplasms and attempting to relate them to their radio-sensitivity or radio-resistance. In fact, it may be shortly conceded that this work is of such a nature that it may have a profound influence upon the surgeon in his decision whether to treat a certain neoplasm by irradiation or by surgery.

In a general way it has been found that highly cellular anaplastic neoplasms that have little or no desmoplastic reaction show a decided tendency to metastasize early, but at the same time are

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highly radio-sensitive. In other words, the potential malignancy of these types of neoplasms is extremely high, and, as is well known, they respond very poorly indeed to surgical intervention. Yet it is a peculiar fact that many of these highly malignant growths respond extremely well to irradiation. These preceding statements, however, must be accepted only as generalizations, as many exceptions to the rules are to be found.

In the nasopharynx several different types of epithelium lining the mucous membranes and associated mucous glands are to be found, and from each type one can assume that a different variety of neoplasm can arise. The surfaces that are covered by squamous epithelium gives rise to the squamous cell carcinoma, which is well known as a relatively slow growing, more or less fully differentiated type of neoplasm that is highly radio-resistant. Certain other portions of the nasopharynx and the ducts of the associated mucous glands are lined by what is known as transitional epithelium. This membrane gives rise to a highly cellular neoplasm that is extremely radio-sensitive and is known as a transitional cell epithelioma. In certain portions of the nasopharynx the normal epithelium is associated with a large number of lymphocytes. It has been assumed that these lymphocytes are in symbiotic relationship to the tissue cells of the mucosa, and it has been suggested that this specific tissue formation be called lymphoepithelium.¹ From this so-called lymphoepithelium arises a highly radio-sensitive neoplasm known as lymphoepithelioma that gives a characteristic microscopic picture. It is really the intent and purpose of this presentation to call the attention of our rhinologic confreres to these two new clinically differentiated types of neoplasms that are so highly malignant and yet radio-sensitive to such an extreme degree.

The peculiar clinical and histologic characteristics of certain nasopharyngeal neoplasms were recognized both by New,² in 1922, and Crow and Baylor,³ in 1923. Schminke⁴ and Regaud⁵, in 1921, described the characteristics of lymphoepithelioma. It was even noted in that early period of time that certain lesions of the nasopharynx were characterized clinically by early cervical metastasis, as well as the fact that there was some difficulty in recognizing the site of the primary lesions. They also describe the

highly cellular anaplastic histology of these lesions, which they found at times difficult to distinguish from lymphosarcoma. It remained for Quick and Cutler,^{6,7} in 1925 and again in 1927, to call attention to these growths and to point out their characteristic microscopic picture and their exceedingly marked radio-sensitivity. Jovin,⁸ in 1926, reported further on the specific features of lymphepithelioma, in regard to the clinical course, histopathology and response to irradiation. Ewing⁹ described transitional cell epithelioma at great length, and in a study of 100 cases of nasopharyngeal malignancies found that 37 per cent were of the transitional type and 11 per cent of the lymphoepithelial type. Only 30 per cent were squamous cell carcinoma. It is thus apparent, in his series of cases at least, that radio-sensitive lesions of the nasopharynx are probably more frequent than the radio-resistant type. Finally Cutler¹⁰ has made a comprehensive clinical study of a number of these cases of radio-sensitive intra-oral lesions in which he calls attention to their characteristic histology, their peculiar clinical course and their marked radio-sensitivity. He further stressed the questionable histogenesis of these lesions and their highly cellular and malignant nature and concluded consequently that surgery is contraindicated and that they were especially suited for radiotherapy.

Although the microscopic pictures, as will be shown, of these two neoplasms are distinct, unique and characteristic, they have a number of other features in common, thus the usual location of the primary lesion is somewhere within the rhino-, oro- or laryngo-pharynx. Grossly there may be but little to differentiate between the two types. They both also show a marked tendency towards early cervical and diffuse visceral metastasis, the liver and retroperitoneal lymph nodes being most commonly affected and less frequently the osseous tissue. On this account many if not most of these cases present themselves to the physician because of the glandular enlargements in the neck. The primary lesion may be difficult or even impossible to detect without a postmortem examination and finally their extreme radio-sensitivity is a characteristic of both neoplasms and the prime feature that lead to their identification and removal from the general class of epidermoid malignancies. This feature is so pronounced

that it may be utilized as the means of differentiation of these neoplasms from the more radio-resistant squamous cell epitheliomata. The distinction in the radio-sensitivity is more easily grasped when one considers that it requires between seven to ten or more skin erythema doses of irradiation to cause a regression of adult squamous cell epithelioma and only three to five skin erythema doses to affect a lympho-epithelioma or transitional cell carcinoma.

TRANSITIONAL CELL CARCINOMA.

Certain parts of the larynx, trachea and esophagus are lined by transitional epithelium, which is found especially in the ducts of the associated mucous glands. These areas of transitional epithelium may be the origin of these peculiar neoplasms called transitional cell carcinoma. However, it has also been suggested that they may arise by anaplasia or metaplasia of ordinary squamous epithelium and, in fact, many students of the histogenesis of this growth are more inclined towards the latter explanation. The

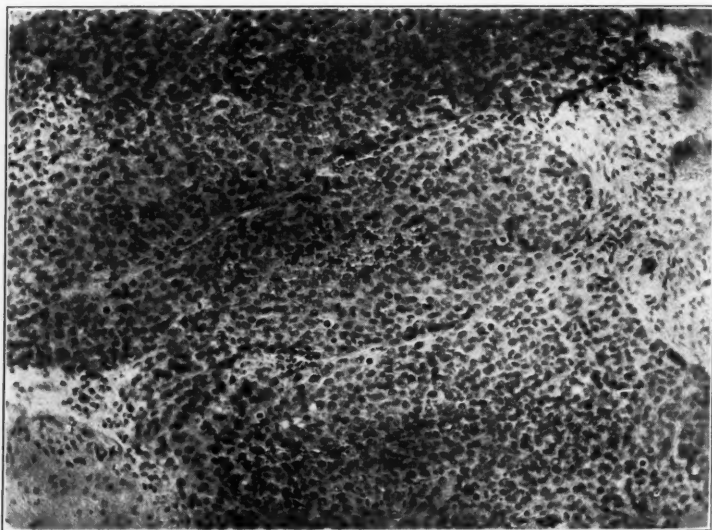


Fig. 1. Transitional cell carcinoma of nasopharynx.

otolaryngologist will encounter them most frequently in the nasopharynx, tonsil, base of the tongue, larynx and esophagus. Grossly the lesion is small and may be incapable of clinical detection. As a rule, the growth exhibits itself as a flat, elevated, infiltrating mass with a granular ulcerated surface. Infrequently the lesion may show as a large tumor bulging into the nasopharynx. Almost invariably there is an early involvement of the cervical lymph nodes and later wide and distant visceral metastasis. Microscopically (Fig. 1) the lesion will be seen to be composed of small polyhedral or round cells which show marked variation in size and staining quality. The nuclei are large and characteristically hyperchromatic, occupying practically the entire cell, and in many instances showing mitotic figures. The neoplasm, in fact, is so highly cellular and the anaplasia so pronounced that there may be difficulty in establishing the epithelial nature of the growth at times. The cell growth is diffuse and arranged in sheets and cords with very little intercellular connective tissue. From this description it can be seen that the picture may simulate a lympho- or round cell sarcoma and indeed may only be differentiated from such neoplasms with difficulty. It is to be understood that pavement, squamous and spindle cell features are never present.

LYMPHEPITHELIOMA.

It has been promulgated by Mollier and Jolly that the epithelium lying in close association with the lymphoid tissue in and about the naso- and oro-pharynx has been modified by this relationship and forms a special type of tissue structure called lympho-epithelium. This peculiar tissue, based upon the intimate association or even symbiosis of squamous epithelium and lymphocytes, has been held to be the site of origin of a peculiarly radio-sensitive growth known as lymphoepithelioma. Grossly the lesion resembles to a more or less degree that of a transitional cell carcinoma described above. Microscopically (Fig. 2) the characteristic picture is that of a highly diffuse infiltrating cellular growth appearing in wide sheets or cords with characteristic areas of infiltration with lymphocytes. The cells themselves are large with a very faint staining protoplasm and cell membrane, thus often giving one the impression of a syncytial mass. The cells them-

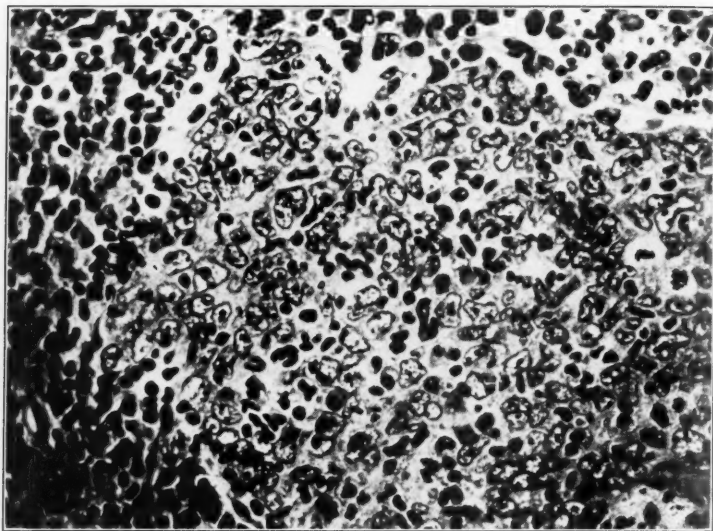


Fig. 2. Lympho-epithelioma of the nasopharynx.

selves contain large clear nuclei with a prominent nucleolus, which often shows mitotic figures. Throughout various portions of the structure are large infiltrations of lymphocytes, which in certain areas may be so dense as to obscure the underlying neoplastic tissue. Here, as with transitional cell carcinoma, squamous, pavement and spindle cell features are not observed.

The following two case reports illustrate both of the above mentioned neoplasms.

Case 1. *Lympho-epithelioma of the Nasopharynx*.—Mrs. L. K., age 61, was referred for treatment of a tumor of the nasopharynx. She claimed that her difficulty started about ten months previous to the time of her visit to us, when she noticed some difficulty in naso respiration associated with a slight amount of discharge and a nasal twang in her speech. She also observed a progressive loss of her sense of smell. Three months later she noticed the hearing in her left ear became poor and that about

the same time swelling on the left side of her neck made its appearance. Her nasal respiration became progressively worse until at the present time she was unable to breathe through her nose. By anterior rhinoscopy a grayish mass was seen in the postnasal space. There was no evidence of any respiratory excursion through the nose by the breath plate or the cotton test. Postnasal examination disclosed a large mass that entirely occluded the nasopharynx and bulging the soft palate forward. Both ears showed a somewhat opaque retracted dull membrane. The hearing in the right ear was normal and in the left ear reduced to whisper voice at three feet. Biopsy was reported as either a lympho-sarcoma or lympho-epithelioma by the frozen section. Several days later the permanent section was returned by the pathologist as lympho-epithelioma. (Fig. 2.) The section showed characteristic large cells with the clear nuclei and prominent nucleolus. The characteristic infiltration with lymphocytes was also present. Knowing the highly radio-sensitive nature of this growth, it was decided to depend solely upon irradiation in the treatment of both the primary lesion and secondary glands in the neck. Eight one and one-half millicurie gold seeds having a 0.5 mm. wall were implanted throughout the growth and the neck irradiated with deep X-rays delivering 110 per cent skin erythema dose to each side with a filtration of one-fourth mm. copper and one mm. aluminum. Three days later it was noted that the glands of the neck were smaller and the patient believed that she could breathe more easily. The following week the nasal twang in her speech had disappeared and the breath plate showed a good respiratory excursion of air through the nostrils on both sides. Postnasal examination showed only a very small amount of tissue situated high up on the left side of the posterior pharyngeal wall. The glandular enlargement of the neck had decreased to such an extent as to be barely perceptible. This response in a period of only ten days following irradiation was highly spectacular and startling. She was instructed to return home to remain under the observation of the referring rhinologist and to return in two weeks. When seen later, at the appointed time, she looked and felt well. Her voice was normal and there was a good respiratory excursion through both nostrils. Nothing

could be observed in the nasopharynx and the glands in the neck had entirely disappeared. The hearing in her left ear returned to normal. This re-examination was made exactly twenty-six days following the irradiation. She has been seen at various intervals since that time, and today is apparently well with no evidence of recurrence in the nasopharynx or in the neck.

Case 2. Transitional Cell Epithelioma of the Nasopharynx.—Mr. R. H., age 46, was seen July 17, 1931, complaining of a swelling of the left side of the neck for the past three months. He had been under the care of physicians at a distant city, who made several speculative diagnoses in regard to his difficulty. There were no other symptoms or complaints. Examination of the nose by anterior rhinoscopy showed nothing of importance. The teeth, tonsils and larynx were also negative to examination. The postnasal examination, however, revealed a small neoplasm high up in the nasopharynx just behind Rosenmüller's fossa. It was about one centimeter in diameter and showed as a reddish flattened elevation with an ulcerated surface coated by a crust. Removal of the crust revealed a granular surface beneath. A small portion was removed for biopsy, and microscopic examination disclosed a transitional cell carcinoma, with the characteristic diffuse hyperchromatic cell growth. On July 24th, the palate was retracted by means of two catheters inserted into the nose and removed through the mouth and two one millicurie gold seeds having a 0.5 millimeter wall were inserted. On July 26th, a radium collar was applied to the neck, giving a total of 7200 milligram hours of irradiation at 2.5 centimeters distance with a 1.0 mm. platinum screen. Both the original lesion and the cervical adenopathy were prompt in their disappearance. The patient returned to his home town and was seen one month later without any apparent recurrence in either the nasopharynx or the neck. He has been seen several times since and is apparently well as yet.

These two cases are not reported as clinical cures, as they have been under observation for a period of only about six months. They are described merely as illustrative of the lesions noted above. These growths offer a poor if not altogether hopeless prognosis if the attempt is made to treat them by surgery alone. The surgical inaccessibility of the growth, its highly malignant

nature, the early cervical metastasis are all important factors that contraindicate surgical intervention. On the other hand, their pronounced susceptibility to irradiation may alter the prognosis materially. If the process is seen early, before visceral metastasis has occurred, it is theoretically possible to secure a cure by irradiation alone. Unfortunately at this time we have no means at our command that will enable us to determine if microscopic diffusion of the tumor has occurred at a distance. The irradiation must be adequate and sufficient to completely sterilize the primary growth and the secondary deposits within the neck. That this is more than a speculative possibility can be attested by Cutler's¹⁰ report of nine cases, apparently well for a period varying from three to eleven years following successful irradiation.

CONCLUSIONS.

1. Attention is called to two relatively newly described types of malignant epithelial neoplasms of the nasopharynx lympho-epithelioma and transitional cell carcinoma.

2. These growths are characterized by a specific unique histology, a small and frequently undetectable primary lesion, early cervical metastasis and pronounced radio-sensitivity.

3. The biologic properties of these neoplasms contraindicate surgical intervention, while their radio-sensitivity render them especially suited for treatment by irradiation.

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(This is the second of a series of articles dealing with neoplasms of the nose, throat and ear, by Drs. Beck and Guttman. The next article will appear in an early issue.)

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XXVII.

UNDERLYING FACTORS IN THE ZINC IONIZATION
TREATMENT OF MIDDLE EAR INFECTIONS.*

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The treatment of middle ear infections with zinc ionization, resulting in varying degrees of success, has been reported on numerous occasions. The treatment is designed to destroy bacteria and to stimulate the repair of the tissues. In certain selected patients at the University Hospital, particularly those showing persistent aural discharge following radical mastoid operations, this form of therapy has been fairly satisfactory. Several years ago, however, it became evident that the use of the electric current apparently had little to do with the results attained.

The purpose of this investigation has been to determine the effects of zinc sulphate upon bacteria, with and without the electric current, and also to study the extent of the electroplating of tissues during ionization, as has been reported by several authors.

The "zinc ionization" treatment for chronic suppurations was devised by Friel.¹ The term "ionization" is misleading, since zinc sulphate solutions are already ionized, and electrolysis is supposed to take place during the treatment. Friel employed 20 to 30 milliamperes of current when his patients were under the influence of anesthetics. He used various currents for other forms of infected lesions. Most users of the treatment have found that patients without anesthetics will not tolerate more than 4 milliamperes of current. Warwick and Stevenson² have stated that zinc chloride is the evident cause of the bactericidal effect. These

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A preliminary study of the physical, chemical and bactericidal factors involved in the zinc ionization treatment.

authors believe that the ionization produces intracellular diffusion of the zinc ions and that this is more effective than the introduction of zinc sulphate alone, which they describe as intercellular diffusion. Among recent supporters of the treatment are Hett, Wells and Levick,² who state that "the zinc ions, as soon as they enter the tissues, surrender their charge to hydrogen ions and remain in situ as atoms of zinc." They also are the authorities for the statement that "the atoms are deposited upon and just beneath the surface of the tissue in the manner of electroplating."

On the supposition that zinc remained in the tissue, a number of experiments were made to find out to what extent this occurred. First, X-ray pictures of the ionized tissue were taken. The results were negative, showing no deposition of metallic zinc probably because the particles, if present, would have been of such minute size that the emulsion of the film would have obscured them.

A second group of experiments involved the electrolysis of zinc sulphate solution in a tube in which the cathode was separated from the anode by a silica gel bridge. A phosphate buffer mixture with a pH of 7.4 was placed around the cathode. If zinc ions migrated into the gel, a white layer of zinc phosphate should be formed, or a layer of metallic zinc should be visible. The same current as advocated in the usual treatment and even three times this current was applied in these experiments. No metallic layer was visible. In another experiment, an agar bridge was substituted for silica. The surface of the agar next to the anode and the zinc sulphate solution was shrunk and withered after the experiment. The usual current of 4 milliamperes was applied for 20 minutes. No layer, indicating the deposition of a zinc salt, was seen, even upon examination with the microscope. One of the silica gel bridges was allowed to stand with the solutions on each side for 24 hours. The current had been used for twenty minutes only. A white deposit in the center indicated that the zinc sulphate and the phosphate buffer had diffused into the gel.

The third method of approach was the qualitative chemical analysis of tissue following ionization of the tympanic cavity. The

patient (M. P.) had received the ionization treatment twice prior to the operation, the second treatment being given about four hours before the removal of the tissue. The tissue equaled in mass an average size garden pea. It was digested with sulphuric and nitric acids, brought to a pH of 4.6 with sodium hydroxide, and the precipitation of zinc as the pyridine thiocyanate was carried out according to the method of Pagel and Ames.⁴ No precipitate, indicating the presence of zinc, was visible even after four hours' standing.

Lastly, analysis of ionized tissue by the spectrograph was done. The infected membrane from the frontal sinus of a dog was selected as a suitable area for experimental study of the ionization treatment. The area was ionized in the usual manner, and the excess zinc sulphate was washed out with normal saline to remove any zinc occluded by the tissue. The infected membrane was then removed and put into a pyrex flask for digestion. The other frontal sinus was used as a control and was treated in the same manner as in the experiment just described. This time, however, no electric current was used. The sinus was filled with zinc sulphate solution and allowed to remain for the usual twenty minutes. The membrane was then washed with normal saline as before and an equivalent amount of tissue removed.

Both ionized and control samples were digested with sulphuric and nitric acids until a colorless solution was obtained. These samples were analyzed for the presence of zinc by Mr. D. C. McCann, of the Department of Analytical Chemistry, who employed the spectrographic method. The results are indicated in Figure 1.

The analysis of the tissue shows the following:

1. There is only one line in the plate which might be assigned to zinc—the line at 2771 Å. Since this line is no more persistent than the others indicated, there is no reason to believe it is zinc.
2. Should the above line be due to zinc, since it occurs in both the control and the electrolyzed tissue, it would probably be due to traces of zinc in normal tissue, as in the case of the calcium and magnesium shown.

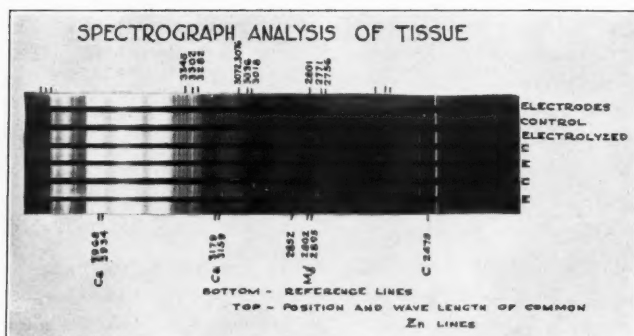


Fig. 1.

The prints do not show the details of the analysis as well as the original plate. Three photographs of both control and ionized tissue specimens were made. The lines in the spectrum indicating the presence of magnesium revealed that the sample of material used was sufficiently large to detect even faint traces of zinc had they been present. We believe that the spectrometric method is the most reliable analytical procedure for the determination of zinc in small amounts of tissue. It is far more rapid than many methods described in the literature, and a large number of determinations may be made upon an extremely small amount of material. The method is also not restricted by the interfering substances occurring in the tissue.

The second phase of this article is concerned with the study of the bactericidal effects of ZnSO_4 with and without electric current. Literature on the effect of salts of heavy metals upon the viability of bacteria is voluminous. The most complete bibliography is that made by Falk,⁵ though the work of Moore and Hawkes⁶ is one of the few publications discussing zinc salts as germicides.

According to Zinsser,⁷ the effect of electric currents on bacteria has not been satisfactorily demonstrated.

Thornton⁸ studied the effect of current alone on the bacterial cell. He found that the retarding effects upon bacterial growth

were heat, electrolytic effects within or without the cell, and the mechanical action of alternating currents upon protoplasm. The temperature was kept constant: 210 volts per cm., and 0.3 amperes were used. The human subject could not tolerate so strong a current.

When Kruger¹⁰ employed a current of 20 m.a. for twenty-four hours he was able to kill *B. tetanus*, pneumococcus and other bacteria. Zeit⁹ found that current alone was not responsible for the destruction of bacteria, but that the products of electrolysis, i. e., oxygen and hypochlorous acid, formed at the electrodes, were the probable additional causes. When the effect of temperature was controlled, the current alone had only slight antiseptic effects. It is, therefore, reasonable to assume that a current of 4 m.a., employed for from fifteen to twenty minutes, would have little effect upon the viability of bacteria.

The zinc sulphate employed in our experiment was a 2 per cent (1-50) solution of Mallinckrodt's C. P. grade. The salt was the hydrated variety containing seven molecules of water. It contained, according to the label, no arsenic nor heavy metals. Iron, 0.001 per cent, and manganese, 0.001 per cent, were present. In the heaviest concentration in these experiments, .0024 mg. of manganese was present. There is no reason to suppose that manganese or iron in these concentrations could exert any definite antiseptic effects.

Glass bottles of 50 cc. capacity were set up with electrodes of 3 mm. zinc wire spaced 1 cm. apart. The electrodes were inserted through a rubber stopper. For a control, a similar bottle was used, with a plain rubber stopper. The equipment and solutions used were autoclaved for fifteen minutes at 15 pounds' pressure. All glassware was chemically cleaned with strong chromic acid. All dilutions were made with accurate pipettes. The total volume of fluid in each case was between 10 and 14 cc.

Pure cultures of the organisms were obtained and subcultured on blood agar slants. Suspensions were made with 4 to 6 cc. of distilled water. One cc. of the suspension was used in each case. Two bottles were set up for each dilution, and the organisms were subjected to the treatment for fifteen minutes. In the ionized

TABLE I
Effect of various dilutions of zinc sulphate solution, with and without current, on pathogenic bacteria.
Time: 15 minutes. Direct current: 4 milliamperes.

Organism	Dilutions										Control
	1:50	1:70	1:100	1:200	1:400	1:750	1:1500	1:3000	1:4500	1:6000	
Staph. Aureus											
A.											
With current	+	—	+	+++	+	±					4 +
Without current	+	—	+	++	+	±					4 +
B.											
With current	+	+++	++								4 +
Without current	++	+++	++								4 +
Strep. Viridans	1:50	1:60	1:75	1:100	1:150	1:300	1:450	1:600			Control
A.											
With current	—		—	—	+	+++	++	++	++	++	4 +
Without current	—		++	—	++	+++	+++	++	++	++	4 +
B.											
With current	—	—		—							4 +
Without current	—	—		—							4 +
C.											
With current				+							4 +
Without current				+							4 +
B. Coll	1:50	1:55	1:60	1:70	1:100						Control
A.											
With current	+		+	+	++						4 +
Without current	+		+	+	++						4 +
B.											
With current		+++		+++							4 +
Without current		++		++							4 +
(Growth after 24 hours 1:50)											
		++		++							4 +

sample the current was kept between 3 and 4 m.a. The bottle was rotated from time to time to insure thorough mixing. The cathode was darkened by a slight, powdery deposit of zinc at the end of the experiment. The organisms were recultured directly to blood agar plates and growth compared to that on a blood agar control slant at the end of twenty-four hours. The control slant was considered 4 plus.

Cultures of *staphylococcus aureus*, *streptococcus viridans*, *streptococcus hemolyticus*, *pneumococcus*, diphtheroids and *B. coli*, all isolated from virulent colonies, were subjected to the action of zinc sulphate with and without the 4 milliampere direct current. It is evident from Table I that the bactericidal action of the zinc sulphate solution alone was fully as effective as the combined action of the zinc sulphate and the electric current. Four milliamperes of electric current applied for fifteen minutes to a suspension of *streptococcus viridans* in normal saline had no appreciable effect on the viability of the organism. This organism did not survive a similar exposure to 1:50 zinc sulphate solution without passage of the current. *Pneumococcus* was also readily destroyed by zinc sulphate. *B. coli* and *staphylococcus aureus* were the most resistant to the treatment of the organisms studied. The primary effect of the ionization treatment is, therefore, due probably to the bactericidal action of the zinc sulphate solution, which is shown by results in Table I.

A group of cases was studied, that the hydrogen-ion change during the ionization treatment might be observed. The change was slight, and the increase in pH concentration was not noticeable. It was felt that the purulent discharge, which is always present, and the amount of surface exposed, all contribute to cause a variation in the pH of the solution. The acidity of the solution may exert an antiseptic influence by itself, in addition to the bactericidal effect of the zinc ion. Otherwise, the shift in pH of the solution during the treatment is not particularly significant, since the actual shift in pH is marked by so many uncontrollable factors.

An attempt to analyze the zinc sulphate solution before and after treatment is theoretically unsound, since the zinc is replaced from the anode which becomes partially dissolved during the

electrolysis. Suppuration occurs during the treatment and this alone dilutes the zinc solution sufficiently to introduce great error. One patient was so treated and the zinc solution recovered from the ear was analyzed for zinc. Two controls were also run. Table II.

TABLE II.

Analysis of Zinc Solution Recovered from the Ear Cavity After Ionization.		
Control (1)	0.8 c.c. Zn SO ₄	4.5 mgs. Zn
Control (2)	0.8 c.c. Zn SO ₄	4.6 mgs. Zn
Sample recovered from ear (0.8 cc.), 5.3 mgs. Zn.		

Woodruff and Bunzel, quoted by Falk,⁵ believe that "ionic efficiency" and toxicity are related to ionic potential. Warwick and Stevenson³ believe that zinc chloride is responsible for the bactericidal effect. Other salts of zinc, e. g., the lactate and the acetate, may prove effective. The correctness of these views may require further evidence, although the toxicity of the zinc ion for bacteria is well known. It seems unlikely that the major effect of the zinc sulphate is due to pH changes. Such changes were measured on suspensions before and after ionization. The results are recorded in Table III. It is doubtful if the shift

TABLE III

Hydrogen-ion changes in suspensions of bacteria in zinc sulphate solution before and after ionization.

Organism	Dilution	With 4 M A Current pH	Without Current pH	Indicator
Zn SO ₄ alone	1:50	5.4 5.4	4.4 4.6	Methyl Red Bromcresol Purple
Pneumococcus	1:100 1:200	6.0 6.2	5.7 5.6	Methyl Red
Strep. Viridans	1:100 1:200	6.0 6.2	5.6 5.8	Bromcresol Purple Bromcresol Purple
Strep. Hemolyticus	6.0	5.4	Bromcresol Purple
B. Coll	1:70 1:100	6.0 6.0	6.0 6.0	Bromcresol Purple
Staph. Aureus	6.2	5.6	Bromcresol Purple
Diphtheroids	1:60 1:100 1:200 1:200 1:400 1:400 1:600 1:600	5.8 6.0 6.4 6.4 6.4 6.6 6.8 6.4	5.4 6.0 6.4 6.0 6.3 6.2 6.4 6.3	

in pH during these experiments had any significant effect on the viability of bacteria. Since some of the zinc sulphate is allowed to remain in the ear, the bactericidal effect may be more pronounced clinically than is indicated in the tables.

SUMMARY AND CONCLUSIONS.

1. The possibility of the deposition of metallic zinc in living tissue is remote and open to question.
2. The spectroscopic is particularly adapted to the detection and estimation of small amounts of zinc in tissue.
3. The use of small electric currents in the treatment is of doubtful value so far as the bactericidal effects of such currents are concerned.
4. The value of zinc sulphate as a bactericide has been studied. The beneficial effects of the treatment are probably due primarily to the destruction of bacteria by the zinc sulphate; the effect of the current is of slight importance.

Grateful acknowledgment is made for the suggestions and assistance of Mr. D. C. McCann, Dr. Genevieve Stearns and Dr. Gordon Harkness.

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XXVIII.

CHONDROMA OF THE LARYNX: REPORT OF SIX CASES.*

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INTRODUCTION.

Few laryngologists of even wide experience have encountered more than one cartilaginous tumor of the larynx. Knowledge concerning the clinical characteristics of the lesion which permits early recognition and effective treatment must, therefore, accumulate slowly, and it would seem advisable to record each case of chondroma of the larynx. Seven patients with tumors of this type have been examined in The Mayo Clinic. These, with the exception of one reported by New, in 1918, are presented herewith.

The literature on the subject was carefully reviewed by New and more recently by Moore, who thoroughly reviewed data up to 1924. Moore summarized each of the sixty-one cases recorded in the literature since the first tumor of this type was described by Heusinger, in 1822, and added one case of his own. Four of the sixty-two cases were excluded because they had been diagnosed clinically on what he considered insufficient evidence, and five others were excluded since they were apparently hypertrophic tissue rather than true neoplasms. Clerf, in 1929, reported one case and reviewed six cases that had been recorded between 1925 and 1929. A review of the literature since 1929 has yielded two additional cases: one by Kurzhals, that of a man, aged eighty-one years, and another by Huttner, that of a man aged fifty-eight years. Thus the recorded cases and the six cases presented here bring the total number to seventy-seven.

Various plans for classifying cartilaginous tumors according to site of origin and histology have been presented since Müller,

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in 1836, first applied the term "chondroma" to the entire group. Virchow, in 1863, suggested the two subdivisions "ecchondroma" and "enchondroma," depending on whether the tumor had originated in pre-existing cartilage. His classification has been generally accepted up to the present, although both Alexander and Moore made additional subgroups. From a general pathologic standpoint the subdivisions suggested by Virchow are useful. As far as cartilaginous tumors of the larynx are concerned, however, such a classification seems of little practical value and tends to cause confusion. Mansfeld, in 1909, made the apt statement that if Virchow's classification is adopted, all cartilaginous tumors of the larynx so far recorded in the literature must be regarded as ecchondromas, because all of them have originated in one of the pre-existing laryngeal cartilages. The same observation applies equally to the tumors reported since that time, with the possible exception of some of the pedunculated growths. There is little to warrant the inclusion of the mixed tumors in a consideration of these growths, either from a clinical or pathologic standpoint. The mixed tumors are always mildly malignant, which can scarcely be said of many of the chondromas. In addition, although cartilage is a common constituent of mixed tumors, the other cellular elements present predominate markedly.

The six cartilaginous tumors in my series are in striking contrast, with approximately 600 malignant neoplasms of the larynx observed in the clinic during the same period. Moreover, during the last year ninety-seven patients with laryngeal carcinoma were examined, whereas none with chondroma was seen. In five of the six cases in the series, the nature of the growth was definitely proved microscopically; all were pure chondromas except one, which was reported an osteochondroma. In the remaining case the diagnosis was based on clinical and roentgen-ray evidence only, but appeared conclusive. An additional case of chondroma of the upper part of the respiratory tract has been encountered recently. It was situated entirely below the larynx, and is not considered in this series. Two of the six patients were women and four were men. They ranged in age from thirty-four to sixty-four years, averaging fifty-two years. In the group reviewed by Moore, the youngest patient was a girl, aged seventeen years, and the oldest, a

woman, aged ninety-two years. Men outnumbered women in Moore's series almost four to one, although the sex was not stated in eight of the cases.

SYMPTOMS.

The symptoms of chondroma of the larynx are in general those of any slow growing neoplasm of this organ. Hoarseness, dyspnea, cough, aphonia and dysphagia as a rule develop in the order mentioned, although their severity and sequence of development varies with the site of origin, size and rate of growth of the tumor. Dyspnea and hoarseness are the most common symptoms. These were complained of by all of the patients in my series. Dyspnea was the initial symptom in half of the cases. In the remaining half the change in voice was noted prior to the development of respiratory difficulty. Depending on the situation of the growth, however, a palpable mass in the neck is sometimes the first evidence of trouble noticed by the patient, and removal may be effected before any of the other symptoms mentioned have appeared. (Fig. 1.) The presence of a tumor in the region of the thyroid cartilage had been noted by three of the six patients. In one instance the patient's attention had been directed to it by his barber three years prior to examination, and it had remained symptomless for two and a half years subsequently. Because of the inactivity of these neoplasms and the fact that they rarely ulcerate, symptoms usually come on so insidiously that it is difficult for the patient to assign a definite time of onset. The patients had been aware of the presence of trouble for from six months to five years prior to examination. Progression of symptoms is likewise slow, so that marked laryngeal or esophageal obstruction, or both, will frequently be present without the patient experiencing particular inconvenience or realizing the seriousness of his condition. Three of the six patients complained of dysphagia. One patient had experienced merely a slight choking sensation on swallowing, which was worse when swallowing fluids. Cough was mentioned by only one of the patients.

DIAGNOSIS.

The physical observations in cases of chondroma of the larynx are of the utmost importance in establishing a diagnosis. Fre-



Fig. 1. Chondroma presenting in the right anterior cervical region. A palpable mass in the neck is at times the first evidence of laryngeal chondroma.

quently the nature of the tumor will be suspected from the laryngoscopic examination or from palpating it in the neck. A positive diagnosis of chondroma based on clinical data alone scarcely seems justifiable, however. Most of these tumors arise from the cricoid or thyroid cartilage, and most commonly from their inner aspect. A small percentage originate from the epiglottis and arytenoid cartilage. Laryngoscopic examination of such tumors arising within the larynx usually reveals a smooth, sessile mass covered with normal mucous membrane in which the blood vessels stand out prominently; this feature is especially striking and of itself is strongly suggestive of chondroma. The tumor is hard



Fig. 2 (Case 2). Large chondroma of the larynx. This had arisen primarily from the right lateral aspect of the thyroid cartilage, and was secondarily encroaching upon the laryngeal lumen.

on palpation with a probe and may be pedunculated. If it has been traumatized recently ulceration may be present. There is commonly mechanical interference with the mobility of one or both vocal cords, which may vary from slight limitation of movement to complete fixation. If the tumor is situated below the glottis, as in many cases in which the tumor springs from the cricoid cartilage, it will frequently be well advanced before producing symptoms sufficiently marked or characteristic to permit of diagnosis. In one of the cases in which there was considerable delay



Fig. 3 (Case 4). Chondroma arising from the posterior portion of the thyroid and cricoid cartilages.

in the diagnosis of subglottic chondroma, concomitant bilateral paralysis of the vocal cord, due to syphilis of the central nervous system was present. In this case, slight displacement of the posterior commissure to one side of the median line and a little fullness of one side of the larynx led to retrograde examination of the subglottic area. A small mirror introduced through the tracheotomy opening revealed the presence of the tumor. Chondromas arising from the outer surface of the cartilage, as a rule, have a sessile attachment and clinically present symptomless, hard, smooth or slightly nodular tumors firmly attached to the



Fig. 4 (Case 5). Chondroma of the larynx. The tumor was not visible from above but had necessitated tracheotomy.

larynx. Often in such cases there is a varying degree of compression and distortion of the interior of the larynx.

The diagnosis of chondroma of the larynx can at times be made from the history, together with the physical findings and roentgenographic demonstration of the tumor, but microscopic examination of the tissue is, as a rule, necessary for confirmation. The long history with insidious onset, gradual progression and absence of pain are usually noted. The palpation of a hard mass in the neck, attached to the larynx, with absence of tenderness and the laryngoscopic appearance of a smooth, nonulcerated

tumor covered with normal mucous membrane in which the blood vessels stand out prominently are strongly indicative of chondroma. Positive roentgenologic evidence is of considerable diagnostic importance, depending on the density of the mass. (Figs. 2 and 3.) Frequently a definitely circumscribed tumor can be outlined. Positive roentgenologic evidence was obtained in the four cases in this group in which such examination was made. Unless the roentgenograms are taken with the possibility of a chondroma of the larynx in mind, however, the tumor may not be recognized, due to overexposure of the film. This is more likely to occur if, as is frequently the case, there is no calcification of the growth. Developing below the glottis, such tumors will often escape notice, even with careful examination of the larynx. (Figs. 4 and 5.)

TREATMENT.

The treatment of chondroma of the larynx depends on the situation of the growth, its size, the character of its attachment to the laryngeal cartilages and its activity. Moore stated that the treatment of such growths is analogous to that for carcinoma in the same situation, and is operative. It should be added, however, that the usual benign character of these tumors amply justifies decided conservatism. Laryngectomy is indicated only in case the growth is so extensive that its complete removal would leave a nonfunctioning, collapsed larynx. Adherence to a conservative policy is likely to result in secondary operative procedures becoming necessary in an occasional case, but with the possibility of preserving laryngeal function this risk seems well worth assuming. Removal by indirect laryngoscopy, peroral endoscopy or under suspension is feasible in cases in which the tumor is small and pedunculated or attached to the epiglottis. Seven cases are recorded by Moore in which the growth was removed through the mouth. This procedure was not feasible in any of the cases observed in the clinic. With the tumor springing from the outer aspect of the laryngeal cartilages its removal, together with the cartilage forming its base, is as a rule easily effected. In this event, sufficient cartilaginous support should be left, if possible, to maintain the laryngeal lumen. Two of the chondromas included



Fig. 5. Following removal of the chondroma shown in Fig. 4.

in this report were removed in this manner without opening through into the larynx. In the majority of the cases laryngofissure and enucleation of the growth, together with its capsule, is the treatment of choice. (Fig. 6.) This procedure is especially satisfactory in dealing with tumors in the subglottic region, particularly in the posterior portion. Three of our patients were treated in this manner with entirely satisfactory results. In cases in which a fairly large tumor is situated in the supraglottic portion of the larynx, subhyoid pharyngotomy may offer more satisfactory surgical approach. Preliminary tracheotomy may be ad-

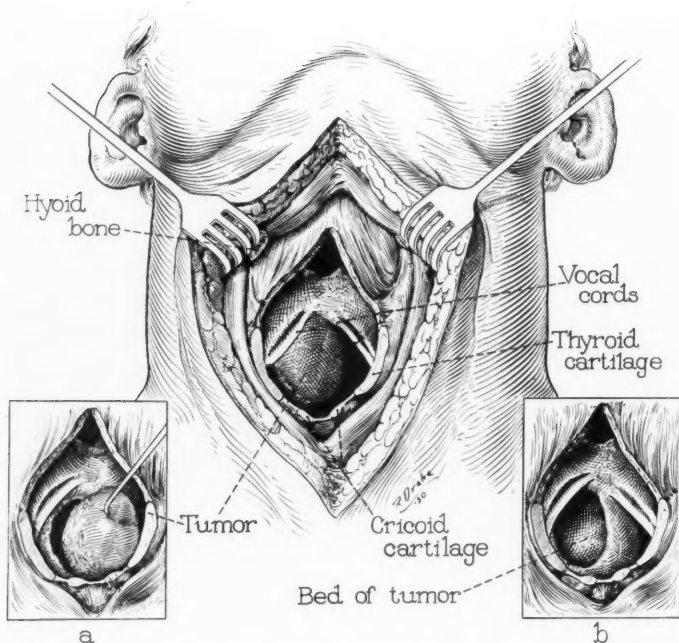


Fig. 6. Chondroma of the larynx shown in Fig. 3 exposed through laryngofissure; *a*, tumor partially freed from its bed; *b*, cavity remaining following complete removal of chondroma.

vantageous with any method of operative treatment, especially if the tumor is producing respiratory obstruction. The procedure is advisable in cases in which laryngectomy is required, as the operation can then be carried out more safely as a secondary stage. In some of these cases it has been deemed advisable to observe the tumor during the course of weeks or months in order to determine its activity before deciding on the type of treatment. Obviously an actively growing tumor will require more radical measures than one of the same size but of slower growth. In the latter instance, it might be possible to enucleate even a large neoplasm, whereas in the former laryngectomy would probably be required. Radium was used in two of the cases while under

observation, but it did not appear to have had any effect on the course of the disease. If the tumor with its capsule is cleanly removed, recurrence should not take place.

A factor tending to render the results of surgical treatment of cartilaginous tumors of the larynx less satisfactory than might be anticipated in view of the benign character of such growths is the common failure to appreciate preoperatively the extent of the neoplasm. As a matter of fact, the surgical mortality in cases of chondroma of the larynx is frequently higher than that in cases of malignant tumors of this organ. This is due largely to the fact that a conservative operation is frequently planned, and after the procedure is well under way more radical measures are found necessary, for which proper preparation may not have been made. Preliminary tracheotomy in such cases is of decided advantage from a technical standpoint, as well as being a factor for safety.

RESULTS.

Three of the six patients in my series were well when last observed, from one to two years following operation. One patient did not remain for treatment and died at home, three and a half years later. The cause of death was not known, but from the extent of the tumor at the time of examination it seems probable that the laryngeal growth was responsible for death. One patient, on whom a first stage laryngectomy for removal of the tumor was performed twenty-one years ago, died of pneumonia. One patient returned to the clinic with extensive local recurrence six years after removal of a chondroma, but refused further treatment.

REPORT OF CASES.

Case 1.—A woman, aged sixty-four years, came for examination April 30, 1910, on account of hoarseness and difficulty in breathing. The dyspnea had first developed four or five years previously and at about the same time a small goiter had appeared. The latter was removed, but the dyspnea progressed and at times had been extreme. The patient had been aware of a tumor in the anterior part of the neck for nine or ten months prior to coming to the clinic.

Examination revealed a hard, nodular tumor in the right side of the neck, fixed to the larynx and producing marked respiratory obstruction. May 10, 1910, the tumor was explored and proved to be so extensive that laryngectomy was necessary. The clinical diagnosis of chondroma was confirmed. The patient died of pneumonia five days later.

Case 2.—A man, aged fifty-seven years, came to the clinic January 23, 1920, on account of a lump in his neck. Three years previously his attention had been called to this by his barber. The mass had gradually increased in size, but he had not been treated for it. Progressive hoarseness had been noted for six months and some respiratory obstruction for a slightly longer period. He had had slight dysphagia for several months.

Examination disclosed a bony-hard and nodular tumor of the right thyroid cartilage about 5 cm. in diameter, which produced marked bulging of the right anterior cervical region. There was no palpable enlargement of the regional lymph nodes. Inside the larynx the tumor was displacing the tissues on the right side markedly toward the left, and the right vocal cord was fixed. There was no ulceration.

The tumor was removed under local anesthesia April 9th. It was necessary to remove practically all of the thyroid cartilage on the right side, but the mucous membrane was not opened. (Fig. 7.) Tracheotomy was not done, as the respiratory difficulty was relieved following removal of the tumor. The patient returned a year later with no evidence of recurrence. The vocal cords moved freely and he had a good voice. A little more than six years after the operation he again returned for observation. At this time there was local recurrence in the right side of the neck; the growth measured about 3 by 3 by 3.5 cm. and was attached to the thyroid cartilage. It was not encroaching on the larynx. The growth had been present for three or four months. Further observation to determine the activity of the growth was advised. On subsequent examination, fifteen months later, there was definite increase in the size of the tumor in spite of radium treatment, and tracheotomy to be followed by laryngectomy was advised. This was refused, however, and the patient has not been heard from since.



Fig. 7. Section of chondroma removed in Case 2. A portion of the fibrous capsule and an area of calcification are shown.

Case 3.—A man, aged thirty-four years, came for examination October 11, 1921, because of hoarseness and difficulty in breathing. Ten months previously he had suddenly lost his voice completely and was aphonic for a period of half an hour. The following night the aphonia recurred and had persisted up to the time of examination. The slight dyspnea which was first noticed when the voice was lost had progressed during this period. The patient had had slight difficulty in swallowing liquids and had lost a little weight. He had not received treatment.

Examination disclosed a smooth, rounded tumor in the subglottic region, covered with normal mucous membrane in which dilated blood vessels stood out prominently. It had a broad attachment posteriorly on the left side and appeared to be fixed.



Fig. 8. Section of osteochondroma removed in Case 3.

Both cords were freely movable. A roentgenogram of the larynx disclosed a circumscribed area of increased density at the level of the cricoid cartilage and a clinical diagnosis of chondroma of this structure was made.

The tumor was explored through a laryngofissure October 19th, and was found to arise from the cricoid and upper part of the trachea. It was extremely friable and was removed in pieces but appeared to come away cleanly. The wound in the larynx was packed with gauze, and later radium was given directly into the cavity on an applicator. Radium was also administered externally. Microscopically, the growth proved to be an osteochondroma. There was no recurrence of the tumor when the patient was last observed, three years later. (Fig. 8.)

Case 4.—A woman, aged fifty-seven years, came to the clinic March 15, 1924, complaining of increased hoarseness and shortness of breath of ten months' duration. This had increased progressively so that she had been quite uncomfortable for the six months prior to examination. At times a choking sensation had been noted on swallowing, especially liquids. She coughed slightly. Her only complaint otherwise was of fatigue. Treatment had consisted of spraying the throat and swabbing.

Examination revealed fullness of the thyroid and cricoid cartilages externally on the right side, with a rounded tumor covered with normal mucous membrane situated posteriorly in the right subglottic region. The right cord was fixed in the median line. General examination was essentially negative otherwise. A lateral roentgenogram of the larynx showed what appeared to be a chondroma of the thyroid and cricoid cartilages. Other laboratory studies were entirely negative.

On account of the extensive involvement and the fact that the tumor was bulging into the posterior part of the subglottic region it was decided to apply radium externally over the neck and observe the patient again in six weeks in order to determine the activity of the growth. Exploration and removal of the tumor at that time were anticipated. The patient failed to return for observation, and died at her home three and a half years later. The cause of death is not known.

Case 5.—A man, aged forty-two years, came for examination July 26, 1927, because of hoarseness and shortness of breath. Change in voice had first been noticed three and a half years previously. During the eight months prior to examination this had become progressively worse and marked dyspnea had developed. A severe cough had been present at first, and this had been productive of blood-tinged sputum for about a week. The cough had since disappeared except for occasional morning and night paroxysms.

The vocal cords were found to be in the bilateral median line position, with the posterior commissure displaced slightly to the left, and the patient was extremely dyspneic. The patient was hospitalized, and the trachea was opened the following morning

with complete relief of the respiratory embarrassment. Roentgenograms of the thorax disclosed evidence of an old tuberculous process in the upper lobes of the lungs, and bronchiectasis in the lower lobe on the right side. Subsequent investigation revealed the presence of late syphilis of the central nervous system, as had been suspected from the paralysis of the vocal cords. The patient was placed on antisyphilitic treatment, but the condition of the larynx remained unchanged at the time of observation, five and a half months later. Roentgenograms of the larynx at that time for possible chondroma showed what appeared to be a soft tissue tumor in the region of the thyroid cartilage. The patient's throat was hypersensitive in spite of cocainization, rendering even cursory examination difficult, and biopsy was not attempted. There was no enlargement of the cervical lymph nodes.

November 4, 1929, the patient was almost aphonic, and a roentgenogram disclosed increased density of the laryngeal tumor. Retrograde examination with a small mirror introduced through the tracheal opening disclosed a smooth, nonulcerated mass completely filling the subglottic space. Since the larynx was now practically functionless, exploration of the growth through laryngofissure was advised. It was anticipated that the tumor would prove to be of low grade malignancy, probably a mixed tumor, and that laryngectomy would be necessary. December 7th, preliminary skeletonization of the larynx and upper part of the trachea was done. A week later the thyroid and cricoid cartilages were divided, revealing a spherical tumor 2.5 cm. in diameter arising from the lower half of the thyroid cartilage on the right side. Its free surface was in contact with the laryngeal wall on the opposite side. The overlying mucous membrane was stripped back and the tumor, which grossly appeared to be a chondroma, together with most of its capsule was removed. Remnants of the capsule were cauterized with the electric cautery. Microscopically, the tumor proved to be a chondroma. (Fig. 9.) The cavity was packed with iodoform gauze and the tracheal cannula was replaced in the trachea. The pack was removed after twenty-four hours. Convalescence was without incident. Ten months later the patient was in excellent general health. He had a very good voice and there was no recurrence of the tumor. It was necessary for



Fig. 9. Section of pure chondroma removed in Case 5.

him to continue wearing the tracheal tube, however, on account of the paralysis of the vocal cord.

Case 6.—A man, aged fifty-eight years, came for examination March 18, 1929, because of huskiness of the voice which had been present for six months. Recently he had noticed that his breathing was slightly labored at times. Laryngeal examination showed a smooth, round, nonulcerated, sessile tumor, measuring about 1 by 2 cm., just below the interarytenoid area in the subglottic region. It did not interfere with the movements of the vocal cords. Clinically it appeared to be malignant, but on biopsy was found to be a pure chondroma. The tumor was exposed through laryngofissure March 27th, and was cleanly removed after incising the overlying mucous membrane. When the patient was last

heard from, sixteen months later, there had been no recurrence of the trouble.

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XXIX.

ALLERGY.

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There is no type of case that comes to me that gives me more worry and is more puzzling to treat and to diagnose than allergic cases. I have nothing new to present and will not offer my opinion as to whether allergy, atopy, anaphylaxis or any other name is more applicable to the condition than the other. The point I wish to convey is that the individual who is hypersensitive is vastly different from the one who is nonsensitive. Proetz¹ has well said that probably no tissue of the body is free from specific reactions to substances foreign to the organism. Therefore, I think that in presenting the subject such titles as allergy in relation to the eye, to the gastrointestinal tract, or to the nose might well be dropped, and as a substitute we could convey the idea to the student and practitioner that the altered condition of the tissues he is dealing with in one or several parts of the body may be either due to allergy or influenced by it. I have noticed in the programs that some phase of this subject is being presented at each of the section meetings. At the Eastern Section meeting the subject of the red septum syndrome is being presented by Jarvis, and diet is being considered at one of the other meetings, so it will be interesting to get the different angles from which the various men have presented the subject.

The successful allergist must be the keenest type of diagnostician, with a wide experience in the symptomatology and physical signs of disease, and he must be ever mindful of the fact that allergy may accompany a true organic lesion. Such qualifications would remove him from the present plane on which he is placed by the laity, and a great many practitioners, as one who merely performs scratch tests.

Another thing that prompts me to present this paper is that in examining the histories of new cases that have been taken by

men who have recently completed their medical course and internship, I am impressed by their lack of training and observation in allergy and by the poor histories they take. They are not able to elicit the presence of this condition from their history taking. I therefore offer as a method of approach the following:

1. A painstaking and complete history, with special reference to a family history of allergy and the environmental and seasonal influences.

2. Complete physical examination, including necessary laboratory work.

3. The scratch tests, if necessary, followed by intradermal tests, and in some instances by contact tests.

4. Diet: the eliminative diets, as have been advocated by Rowe,² and the matter of keeping a food diary, as suggested by Vaughan.³ It might seem that diet should come under the treatment, as it necessarily would, but this is part of the diagnosis, and it may mean that these dietary procedures will have to be observed over a period of months before the proper diagnosis can be established.

It is obvious that if the above plan is followed, it cannot be done by any one individual. It is necessary to have the help of men properly qualified in various specialties.

I feel that the taking of the history in an allergic case is just as difficult as it is important. Patients are evasive, they are forgetful, and they are inclined to minimize the importance of symptoms and of environmental influences. I have found repeatedly on rechecking a history that the patient will completely reverse his statements. I remember in a recent case, that of a woman, the history when completed contained nothing that would give one a clue that she was doing anything in her daily life that might contribute to her symptoms. After going on further in the investigation, when she came back for her skin tests, in which she gave a beautiful positive reaction to orris root, we finally got the information that she was having her hair dry shampooed with orris root powder. Many physicians think it sufficient to ask a patient if he sneezes, if he has hay fever or bronchial asthma, not mentioning the many other conditions suggested by Rowe,² such as common colds, cough, colic, chronic bronchitis, regurgita-

tion, intolerance for certain foods, cyclic vomiting, convulsions, abdominal pain and cramping, urticaria, eczema, angioneurotic edema, dermatitis, migraine, Ménière's syndrome mentioned by Duke,⁴ the middle and internal ear syndrome described by Lewis and referred to by Proetz.¹ Anyone upon reading the article by Levin⁵ will be readily convinced that allergic epilepsy is a true entity, and that hypersensitiveness should be ruled out in all cases.

The history will give hints as to which particular line of examination should be stressed; very often before the history is completed the diagnosis will be well made and will only need to be confirmed by other tests. Valy Menkin⁶ has demonstrated the point that foreign protein introduced into the circulating blood will localize in an inflamed area. This would be borne out by the case reported by Carmack this morning, and should emphasize the interrelationship of infection and hypersensitiveness as well as the importance of knowing as much as possible about bodily function and of seeking foci that might give absorption from bacteria and their products.

While the eosinophiles give no positive information, an increase in these cells in the differential blood smear or their presence in the nasal secretion, particularly an increase of over 4 per cent in the blood smear, should at least put allergy in one's mind and it should be thoroughly ruled out as a cause for the symptoms present in a given case.

Jarvis⁷ has stimulated much interest in the study of the mucosa over the nasal septum and the upper respiratory tract, and uses it as a guide for the acid-alkali food intake, and of the acid-base balance within the system. Certainly the pale, edematous mucosa seen in the nasal chambers of the allergic individual is very characteristic. The case reported by Proetz¹ is a beautiful example of others that might be reported, where finding the typical edematous mucosa in the nasopharynx was the sole evidence of the underlying condition in his case. The patient was not skin sensitive, but he observed the case over a period of time, with the patient always complaining of attacks of vertigo, tinnitus and deafness, and one day when he found him in a typical allergic attack he was able to see the characteristic mucosa in the pharynx and

around the eustachian tube, and by proper diet was able to relieve the symptoms.

The recurrence of nasal polyps, of the nonfibrotic type, is another condition that should make one suspicious of allergy.

Skin tests require skill in performance and in interpretation. Too often they are made by inexperienced persons, and the patient is dismissed with the report that there is no reaction, when a proper technic of the tests would reveal the source of the trouble. No single method is applicable to all, but the person making the tests should have a good knowledge of the habitat and the distribution of the wind-borne pollens. He should know when to be suspicious of the potency of the material he uses; that is very important. Often drug houses put out these products without having them properly standardized and checked, and when the history and other examinations are so positive that they do not correlate with the skin tests the well-trained man may very well question the effectiveness of the antigen and the reagent he uses, and on getting other preparations he will probably be able to demonstrate the proper reactions. He should know when to follow the skin tests with intradermal tests. Otherwise, he may produce alarming and even fatal reactions. He should know when to interpret a false positive (what appears to be a positive skin test when it is due to too large an injection of allergin). Cooke⁸ has demonstrated that 0.01 cc. is a proper amount. Too much reliance cannot be placed upon the skin tests. They are positive only in about 50 per cent of food sensitive individuals and it sometimes is not as important to know what specific proteins produce reactions as it is to know that the patient is sensitive.

Physical allergy has been demonstrated by Duke⁴ and must not be disregarded.

Diet has been so thoroughly worked out by Rowe and by Vaughan, and is so thoroughly covered by Rackeman, Rowe, Vaughan and Coca in their books on the subject, that it would be superfluous to go into details here. The only comment I wish to make is that patients will tell you that they can follow an eliminative diet. They start the diet with the best intentions, but before they get very far will get tired of it and will continually break over.

As to the otologists and laryngologists who seem in doubt that allergy plays much part in their daily practice, I have nothing to say. I am not going on without recognizing it and having the value of these tests. Whether diet influences the reaction of these individuals I am not able to say. There are many interesting experiments. Sulzberger⁹ sensitized guinea pigs intradermally to neoarsphenamin in Breslau, Zürich and America, and found that the percentages of sensitization differed in all three places. These experiments were performed at different seasons of the year. Mayer and Sulzberger found that there were striking differences in the susceptibility to the sensitizations between animals fed on green fodder in summer and those fed on dry fodder in winter. They make the point that green fodder is an alkaline ash that inhibits sensitization and the dry fodder favors it. They summarize their conclusions that there are variations due to change of place, food, race, etc.

As to the fatality reported by Cooke,⁸ after testing with glue, and the one reported by Lamson,¹⁰ after testing with buckwheat, I may say that I have had a serious reaction, characterized by edema, dyspnea, diarrhea and a weak pulse, following the injection of an extract of pollen of 1:100,000 dilution, to a patient suffering from hay fever, with a complete immunity from symptoms for a long period following the reaction.

I have within the past week rechecked the examination of a boy, aged 9, who was referred to me about nine months ago because of failing vision due to a neuroretinitis. His vision is now normal and no treatment was carried out aside from removing the offending proteins.

One further thing is that I think surgical procedures performed on the allergic nose and sinus are not productive of good results, and if surgery is carried out before the underlying allergic cause is found and eliminated the membrane replacing that removed will become allergic again as the new tissue is formed. There is much work still to be done, but I am confident that there is a rich reward waiting in the future and that we will before long be told why some individuals are hypersensitive and others are not.

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XXX.

THE PRESENCE OF PHAGOCYTIC CELLS (HISTIOCYTES) IN AURAL MUCOSA.*

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Ten years have passed since Norval Pierce seized our attention with his masterly review of Wittmaack's huge and laborious text on pneumatization;¹ again, we have heard echoes of squabbles over the "foreign-body" theory, notably before the Copenhagen Congress of 1928, between Portmann, speaking for the late Professor Mouret,² and Wittmaack's adherents.³ Recently Almour and Kopetzky have excellently interpreted Wittmaack's turgid polemics and his tremendous array of histologic data for our better understanding of the etiology of cholesteatoma.⁴

But in all these years of effort, in this field where histologic examination presents extraordinary difficulties, little or no attention has been paid to the connective tissue structures of the ear, regarded as mesenchymal defense mechanisms. Emphasis has been laid on changes in the epithelium, upon osteoblasts and osteoclasts, all examined with meticulous care and commonly under hematoxylin-eosin stains.

While working last year on the similarly neglected field of the "reticulo-endothelial" or histiocyte system in the accessory sinuses, work which has been prosecuted of late through a generous grant by the American Academy of Ophthalmology and Otolaryngology, it occurred to us that investigation of the eustachian tube and middle ear might prove interesting in some of our experimental animals where vital staining had been done.

Without going into historical details, permit me to recall to you that modern physiology and immunology regard the mesenchy-

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mal cells—connective-tissues—of the body as an essential defense against external stimuli. Very important to this defense are the so-called "reticulo-endothelial" cells, histiocytes, which are connective-tissue cells ordinarily quiescent, often found near capillaries, provided with vacuoles able to ingest foreign matter. In other words, these are fixed cells capable of phagocytosis when needed, and they can be detected wherever present in the living body by injecting certain dyes—"vital stains"—india ink or metallic colloids, which promptly show up in the vacuoles of histiocytes throughout the body. Special types of staining worked out by Maximow permit the identification of these elements in human material.⁵

No mention of histiocytes as such is found in any of the voluminous literature of otologic histopathology,⁶ except for two or three very recent authorities whose work will be cited. We may recall that the submucosal connective tissue stroma in the child's ear is rather thick and loose, readily expanding under stress of toxic or foreign-body irritants into granulation tissue masses, under which the subepithelial connective tissue layer becomes very thick and vascular and may even present mucous glands. Over this a layer of ciliated columnar epithelium may, according to Wittmaack, grow in from the tubal ostium, replacing the normal cuboidal investiture and resembling nasal mucosa. Meyer disagrees with Wittmaack regarding ingrowth of ciliated or columnar epithelium from the tube, having observed that the type of epithelium may change in irritated areas remote from that region, even as far away as the mastoid cells.⁸

In the adult, thin connective tissue is normal, increasingly fibrous where early inflammatory changes occurred. This may be especially noticeable about the ligamentous scaffolding of the ossicular chain and about the insertion of the tympanic membrane.

The eustachian tube, lined by ciliated columnar epithelium which lies in lengthwise folds, has numerous mucous glands, and, near the pharynx, a distinct mass of adenoid tissue—the "tubal tonsil," lacking in fetal life, but actively functioning by the second year. The connective-tissue stroma of the tube is loose, but

rather thick and vascular, and is responsible for the longitudinal folding.⁹ McMahon's beautiful work on mastoid histopathology demonstrates the probability of infection traveling via the sub-epithelial areolar tissue about the vessels, and he points out the tendency to fibrotic repair, without referring to the presence of histiocytes, although they seem to be present in his figures.^{12 13}

W. Kolmer, in 1927, quoting the work of Demetriades, who used pyrrhol blue, calls attention to the presence of large cells whose cytoplasm was noticeably filled with blue granules, about the periphery of the membrana tympani, in connective-tissue strands around the ossicles, and about the intrinsic muscles of the middle ear. Considerable amounts of pyrrhol blue were noted in the adventitia of the larger vessels and the narrow spaces of the petrosa.¹⁰

Russi pointed out in 1930 that fibroblasts and elastic or collagenous fibers were the only structures formerly regarded as important in the submucosa. He was unable to find any previous study of the histiocytes in the ear, although other Italian investigators had examined these structures in the pharynx and larynx, as I have reported elsewhere.⁵ Using 1 per cent trypan blue in the dorsal region of guinea pigs, repeated six times on alternate days, he bleeds out the animal, and fixes in 80 cc. of 10 per cent formalin with 20 cc. of saturated picric acid solution. After careful decalcification, with embedding in paraffin, he uses alum carmine for a contrast stain. He finds histiocytes are few in the tympanic membrane; mostly on the outer surfaces and toward the periphery. They are sparsely disseminated under the delicate membrane of the middle ear, more being perivascular, lying in the fibrillæ and about the round and oval windows. In the eustachian tube, a few histiocytes occur in the submucosa, more in the perichondrium. They increase in number toward the tympanic end of the tube.¹¹

Schwarz of Tübingen lately has directed attention to the lack of any individualized study of constitutional tissue developmental tendencies, and the lack of any thorough understanding of the physiology of connective-tissue.¹⁴ He agrees with Sauerbruch that the preordained format (*anlage*) and vital force of the mesenchyme are the foundation of bodily constitution and dispo-

sition.^{15 16} Schwarz examined 202 fetal and newborn temporal bones, in 58 of which there was slight otitis media. He relies on Maximow's descriptions and technic, as we have.

Schwarz points out that in the third and fourth fetal months histiocytes for only 10 per cent of the connective tissue cells present; they increase rapidly after the fifth month, when foreign matter begins to appear in the tympanic cavity. Apparently because of constitutional variations, there is not an absolute proportion between the number of histiocytes found and the amount of foreign matter present; but a noteworthy increase is constant. The histiocytes in later months of pregnancy are very large. According to the grade of infection, not only do leucocytes enter the tunica propria and lumen, but also wandering cells—histiocytes—occasionally very many, in subepithelial masses.¹⁷

Brunner's most recent work contains no mention of histiocytes, but points out (following Jansen) that the eustachian tube and peritubal cells are not especially important in causing irritative changes in tympanic mucosa. After radical operations he finds healing occurs by connective tissue from the marrow spaces, which become overgrown by epithelium.¹⁸

Wittmaack states that new-formed granulation tissue masses in the newborn become overgrown by primitive epithelium,⁷ but Meyer of Würzburg takes issue with him, feeling that the so-called "myxomatous," or "fetal," tissue is nothing but edematous connective tissue not dissimilar to that found in the nasal accessory sinuses and so-called nasal polyps. Meyer points out that in very severe middle ear processes of infancy, with the lumen choked by masses of leucocytes, only the slightest invasion of the mucosal surface occurs, with little or no invasion of the thickened mucosa. To the latter, with its content of reticular cells, and not to the epithelium, he ascribes most of the defense function of the membranes of the middle ear. Admitting that infantile otitis media may arrest pneumatization, he denies flatly that it always does so. He calls attention to Nager's recent work on rickets,¹⁹ where co-existent otitis has arrested pneumatization, and agrees with Albrecht²⁰ that constitutional components, rather than the surface irritation invoked by Wittmaack, are to blame for persistent and recurrent inflammatory reactions.

In chips from youthful mastoids, Meyer finds lymphocytes and leucocytes along with new-formed connective tissue elements in the submucosa; also, there is marked perivascular infiltration. Epithelium was multiple-layered cuboidal. He suggests that the ingrowths of "embryonal connective tissue" into marrow spaces, as noted by Wittmaack, greatly resemble the reticular connective tissue which is the normal support of bone marrow. He feels that the cellular components of the marrow are withdrawn, either absorbed by enlarging blood vessels or changed into fixed connective tissue elements. Thus cellular marrow becomes vascular marrow, or may even become fatty marrow—changes readily observable in bones elsewhere in the body.

Our observations have been limited to vital staining of membranes in the cat, and to a few human specimens from embalmed material, as well as ear polypi and cholesteatomatous masses. For vital staining, we have used trypan blue, 1 per cent; for human material, Maximow's eosin-azur stain. Zenker fixation is preferable, with celloidin embedding.

In the cat, where the membranes are very thin, and fibrous tissue shallow, we found histiocytes sparsely scattered along the eustachian tube and still fewer in the tympanic mucosa, mainly near the capillaries.

In human material from a man of thirty, accidentally killed, signs of early otitis are noticeable in the thickened fibrous layer. Histiocytes are present, however, from the eustachian tube mouth all along the tympanum, gradually increasing with distance from the throat and from the lymphoid deposits there.

A large vascular polyp, removed from an anterior perforation of the pars flaccida in a boy of eleven, whose suppuration had lasted eleven months, presents the usual foreign-body giant cells, a host of plasma cells,²¹ and considerable numbers of histiocytes. Many fibrous connective-tissue cells doubtless represent histiocytes which have completed their phagocytic rôle and are now attempting fibrous repair. It is notable that the active histiocytes crowd near the blood vessels. Marked epithelial thickening and desquamation are also noted.

Granulations taken adjacent to cholesteatomatous masses show more marked fibrotic changes, but numerous histiocytes are pres-

ent. Lacking material for study of acute otitis cases, we have relied on Schwarz, and feel that examination of polypoid extrusions is valid evidence of the probable situation all about the tympanum, wherein connective tissue immunity has been active.

This histologic work was carried on under the direction of Professor Olof Larsell in the laboratories of the department of anatomy, and he has personally studied all the slides and identified the structures named. Typical fields, drawn by his hand, are exhibited herewith. Microphotographs are ineffective for reproducing the delicate colors and fine granular inclusions shown by vital and by eosin-azur staining. Sincere thanks are due this distinguished anatomist for his wise counsel and painstaking supervision of technical details.

As we suggested in 1930, the powerful rôle played by these connective-tissue elements, which, having acted as phagocytes for irritants, revert to their changed form as fibroblasts, challenges the critical imagination.⁵ Healing of the ear in this manner may damage function irreparably. Control of these cells by constitutional means, by the endocrine-sympathetic system, is as yet not within our reach. The rôle of the plasma cell is as yet undetermined in these inflammatory reactions. Perhaps careful study of the connective tissues of such marantic infants as succumb to so-called infantile mastoiditis may determine whether such individuals are constitutionally lacking in the normal degree of histiocytic immunity.¹²

Revaluation of Wittmaack's pneumatization theory on the basis of more modern histologic technic should invite attention from those laboratories equipped for perfusion fixation—especially with Zenker's fluid—of vitally stained animals, especially monkeys. Also, unembalmed recent human material, stained with eosin-azur, or by flotation of membranes on neutral red solution, should be thoroughly examined. Lacking means and material for this difficult work, we can only hope that others may flood with light a region wherein we have peered about with a flickering candle. We can only emphasize the signal importance of the connective tissue as an agent of immunity and of repair, and wish to submit that aural epithelium is not solely guilty of all the crimes laid to its charge.

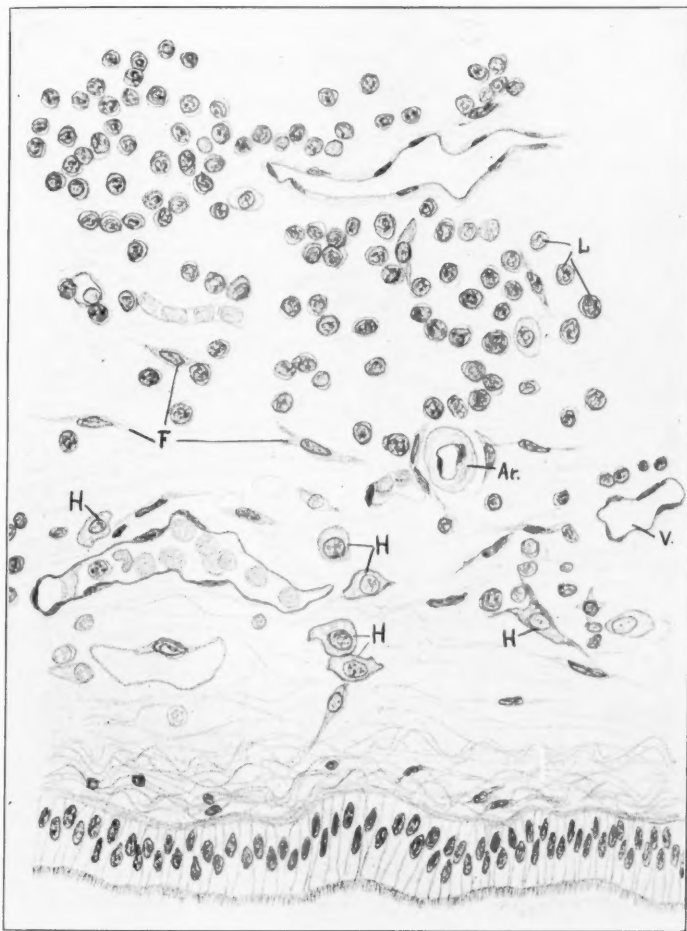


Fig. 1. Mucosa of eustachian tube near pharyngeal orifice (Larsell) showing types of cells—histiocytes, lymphocytes, fibroblasts.
Ar., artery; V., vein. Human. Hematoxylin and eosin-azur stain. All drawings high power magnification.

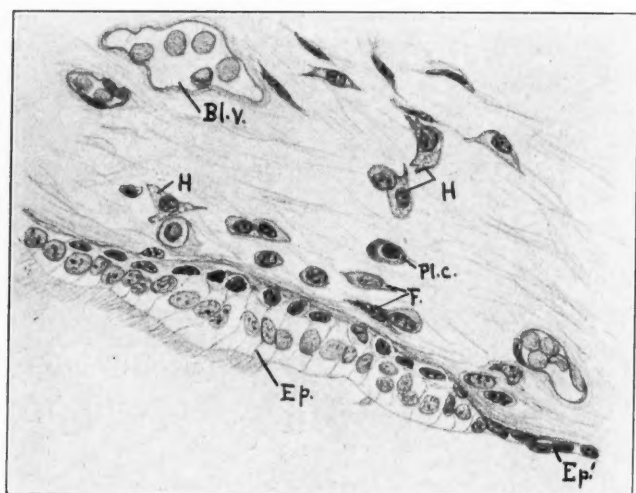


Fig. 2. Mucosa at opening of eustachian tube into tympanic cavity (Larsell). Ep., epithelium of Eustachian tube; Ep', epithelium of tympanic cavity; H., histiocytes; F., fibroblasts; Pl.c., plasma cells; Bl.v., blood vessel.

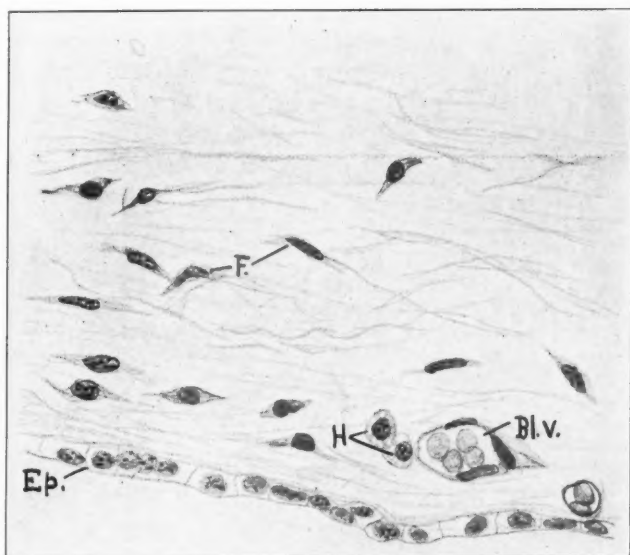


Fig. 3. Mucosa of tympanic cavity (Larsell). H., histiocytes; F., fibroblasts; Bl.v., blood vessel; Ep., epithelium.

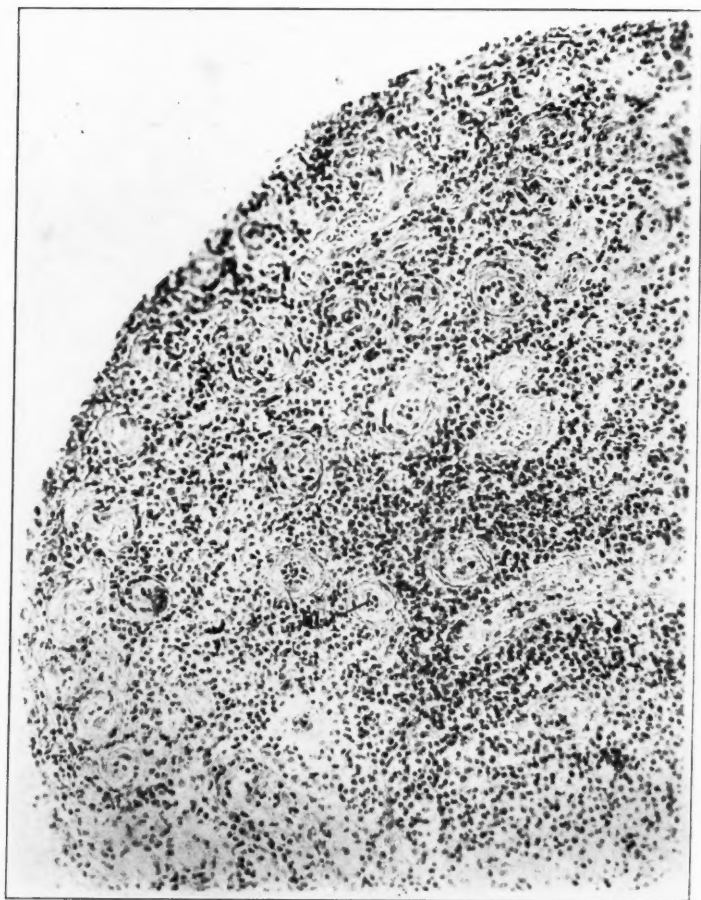


Fig. 4. Photomicrograph of section through ear polyp. Types of cells shown in drawing, Fig. 5.

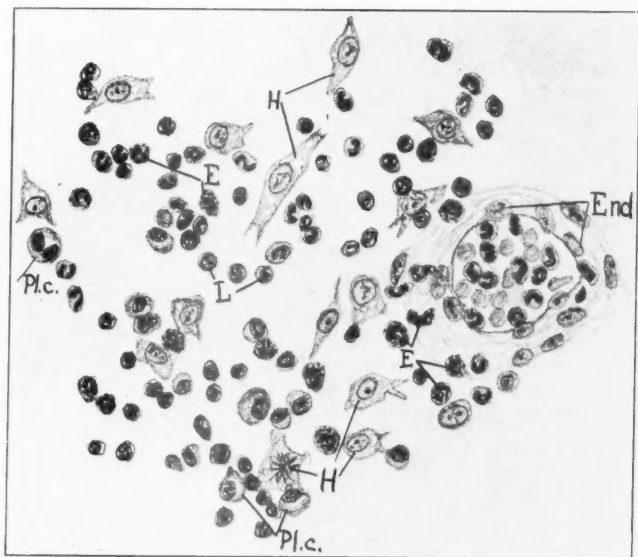


Fig. 5. Typical area in section of ear polyp, showing types of cells (Larsell). H., histiocytes; L., lymphocytes; e., eosinophiles; Pl.c., plasma cells; End., endothelial cells; Bl.v., blood vessel. Note histiocyte in mitosis in lower part of field.

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XXXI.

EMPYEMA OF PETROUS APEX: OPERATION,
RECOVERY.

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Mrs. M. O., 48 years of age, first took sick with an acute purulent otitis media, on the right side, in the early part of January, 1931. A paracentesis was performed and the ear continued to discharge profusely for three weeks. A right simple mastoidectomy was then performed by Dr. George Worcester on January 31, 1931. A few days postoperatively she began to experience pain in the right ear radiating upward over the scalp and forward to the temple. This pain was not very severe at first, but then became progressively more intense. The patient remained at home for three weeks and was then returned to the hospital. The old incision was opened and the mastoid wound re-explored by Dr. Worcester, but nothing was found to account for the severe pain. The pain continued after the second operation and began to be noticed more and more as a deep-seated pain behind the right eye, mostly nocturnal in character. The patient had no vertigo or any signs of labyrinthine disturbance.

An X-ray examination of the mastoid processes and the petrous pyramids was made by Dr. Frederick M. Law on March 18, 1931, and his report follows: "The left mastoid is large and cellular and clear. The right mastoid is postoperative. All the cells have been removed, except for a slight suspicion of several minute cells over the auditory meatus. They are so small that it is really a question whether they are cells or cancellous structure. The remainder of the operated area appears to be clean. The apex of the petrous pyramid on the left is clearly shown and is pneumatic almost to the tip. The petrous pyramid on the right is invisible from the internal auditory meatus to the apex. Not having films made previous to the present attack, no comparison can be made, but it is very unusual to see such a difference in the

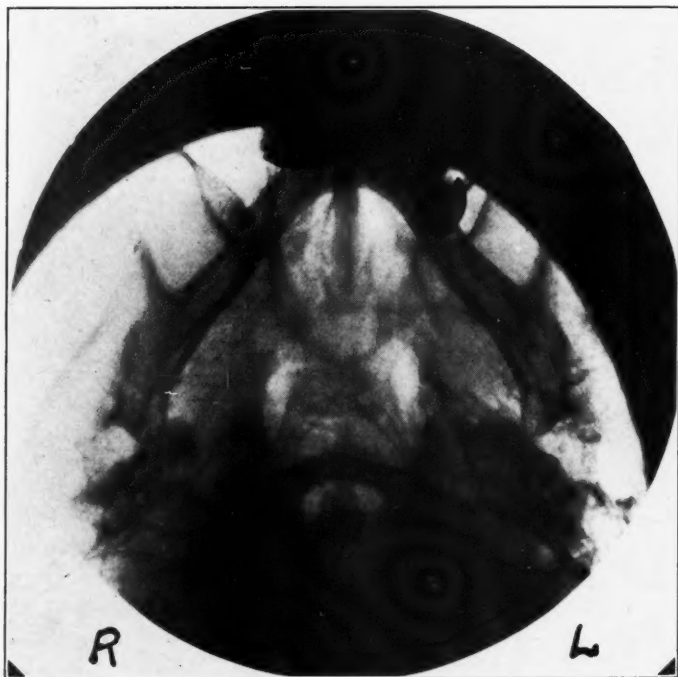


Fig. 1. The left pyramid is clearly shown and is pneumatized to the tip; it shows normal aeration. On the right side the tip shows intense atrophy with complete loss of trabeculation.

two pyramids, and if there are any clinical signs referable to the apex, I would consider that this case represented absorption of the apex of the right petrous pyramid."

The case was seen by Dr. James Dwyer, in consultation with Dr. Worcester, and a diagnosis of petrositis on the right side was made. I saw the patient, at Dr. Worcester's request, on March 21, 1931. At that time the mastoid wound was almost completely healed and showed but a slight purulent discharge. The middle ear, however, was full of pus, and when this was wiped away more could be seen exuding under pressure. The

pain, on this date, was intense and was situated behind the right eye.

The patient was admitted to the Beth Israel Hospital on March 26, 1931. Examination of the blood on that date showed: Red blood cells, 4,290,000 with 79 per cent hemoglobin; white blood cells, 8,400; polynuclears, 63 per cent; staff cells, 3 per cent; mononuclears, 37 per cent. Examination showed the urine to be normal.

The patient was operated upon on the day of admission. The edges of the simple mastoid wound were carefully separated with the periosteum attached and the operated area exposed. The mastoid cavity was found to be filled with granulations. These were removed with a sponge and a curette, and the inner table was exposed throughout. A search was then made in the area below the posterior semicircular canal for a fistulous opening into the petrous bone but none was found. The cavity was converted into a radical mastoid cavity by lowering the posterior meatal wall to its bony limit. It was then seen that there was an erosion present anterior to the superior semicircular canal and above the horizontal semicircular canal. This was covered over by granulations. With the aid of a large burr, the anterior wall of the external auditory canal was thinned down and the zygomatic root was removed. This allowed a full exposure of the mouth of the eustachian tube. The tensor tympani muscle and its bony encasement were next removed and a $1\frac{1}{2}$ mm. burr was placed high up at a level with the roof of the musculotubal canal, $\frac{1}{16}$ inch posterior to the mouth of the eustachian tube and directed at an angle of 22° to the external auditory canal. The petrous tip was entered and found to be one large cavity. The fistulous opening previously described was next widened with a curette and entered with a probe. There immediately followed a flow of about two teaspoonsful of thick, creamy pus. The cavity was then curetted with the Yankauer curette and, during this procedure, there was a continual oozing of pus. The granulations in this cavity were completely removed. A rubber dam drain was inserted into the fistulous opening, the direction of which led directly inward toward the internal auditory meatus. The wound

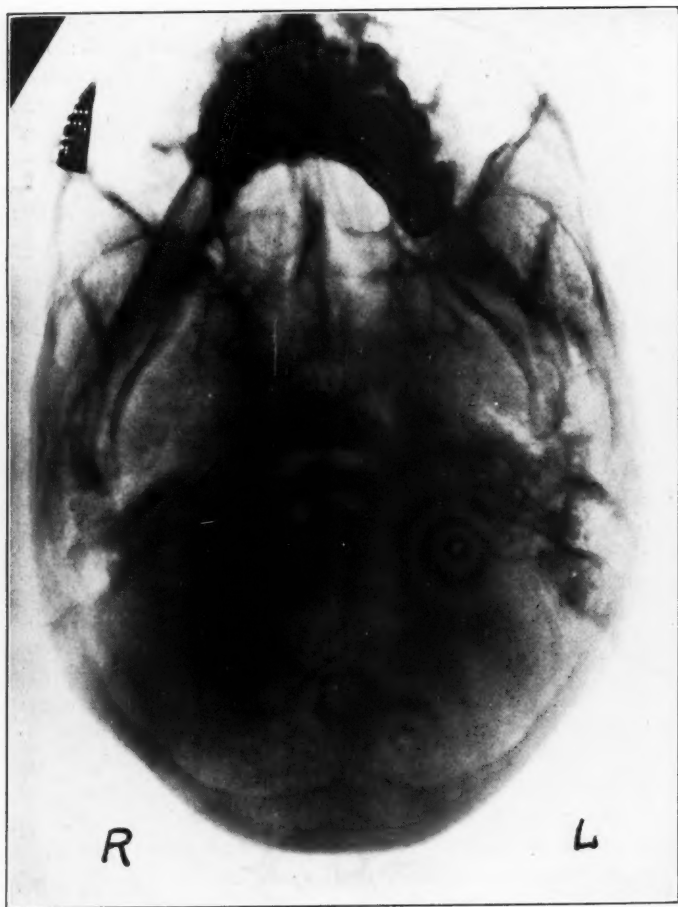


Fig. 2. Droplets of lipiodol in apex of diseased petrosal apex.

was packed with rubber dam and left open. At the end of the operation there was no evidence of facial palsy. The culture of the pus obtained showed a streptococcus hemolyticus anginosus (Hadjopolous).

On the following day the patient complained of a slight pain in the operative area but otherwise was comfortable. A full dressing was done on the 28th, and the fistulous tract found at operation was injected with lipiodol. The radiographic examination of the base, following the lipiodol injection, is reported as follows by Dr. Henry K. Taylor: The left petrous is pneumatic through the entire extent. The right petrous shows diminished aeration with a destructive lesion within the apical portion. There are a few droplets of lipiodol within the apical portion of the right petrous.

For the next few days the patient complained only of severe pain in the region of the mastoid wound. The pain behind the eye had completely disappeared. On April 1, 1931, she was ordered out of bed, on the chair, and from this date on, until her discharge from the hospital on April 4, 1931, all pain in the temporoparietal region and in the back of the right eye had disappeared. Her temperature, throughout her stay at the hospital, ranged between 99 and 100.2, the highest being 101.2 the day after operation.

The patient was returned to Dr. Worcester for subsequent treatment and he performed a plastic operation on the external canal. At the present writing the radical cavity is almost completely healed and the patient is symptomatically well. An X-ray plate of the petrosæ, taken on July 27, 1931, by Dr. Henry K. Taylor, showed the following: The left petrous bone is pneumatized to the tip and shows no abnormal findings. The right petrous bone shows no pneumatization and there is a generalized diminution in aeration. There is a productive inflammatory change in the base of the right pyramid. The apical portion is visualized, is intact, is atrophic and contains the few droplets of lipiodol previously injected. The right mastoid process has been resected and this area is clean.



Fig. 3. Base plate taken July 27, 1931.

COMMENT.

Since the publication of a series of articles on empyema of the pyramidal apex by Dr. Kopetzky and myself,* this case has been operated upon by me but was not included in the original report. Just as all of our cases have shown the symptoms characteristic of a petrous suppuration, this case, also, presented the deep-seated eye pain and the continued otorrhea which could not be accounted for by any lesion within the mastoid process itself. The prompt recovery obtained following the surgical procedure which I have advocated for the relief of this condition is further evidence that a deep-seated suppuration within the petrous apex can be attacked surgically before an invasion of the endocranium occurs.

Futhermore, it is of interest to note that this patient lateralizes sound to the right ear, indicating that the cochlea is still intact. Among the objections which have been raised against this procedure is the danger of injuring either the carotid artery, the cochlea or both. In none of the cases which have been reported in our original article has this happened, nor has it happened in this case. The careful following of the technic outlined will protect these two structures from injury.

51 WEST 73RD STREET.

*Kopetzky, S. J., and Almour, R.: Suppuration of the Petrous Pyramid: Pathology, Symptomatology and Surgical Treatment; *ANNALS OF OTOTOLOGY, RHINOLOGY AND LARYNGOLOGY*, Vol. XXXIX, No. 4, and Vol. XL, Nos. 1, 2 and 3 (1930-1931).

XXXII.

CONCERNING THE NORMAL FUNCTION OF THE
VESTIBULAR APPARATUS.*

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BALTIMORE.

Within recent years considerable skepticism has arisen concerning the usefulness of the semicircular canals and the related organs, the sacculus and the utricle. This is particularly true as regards their putative rôle in aviation. In contrast with the great emphasis placed upon vestibular sensitivity in the selection of American aviators during the World War,²⁶ there now seems to be a growing conviction that the vestibular apparatus, instead of being an essential aid to the pilot, is in some respects actually a handicap. In a recent article, Major William C. Ocker²³ of the United States Army points out that ". . . equilibrium as it applies to flying depends not on the semicircular canals of the inner ear and the muscle sense, but upon the visual sense." He goes on to say that the rotation tests, formerly regarded as quite indispensable in the selection of fliers, are now used mainly to convince the pilot that it is better to rely on mechanical instruments (spnorp to sseunrap 'Sof d'p'edap'is uoisiA n'epw) when vision is impaired by fog, darkness or clouds than to trust his own internal "motion-sensing" mechanism.

Dr. Ralph A. Fenton⁹ has also recently emphasized the general repudiation of the rotation tests in aviation. "Vestibular function," he says, "no longer holds the commanding position in aviation examinations which it did during the war. . . . Vision has, as predicted during the war, turned out to be far more important than balance."

In this connection Dr. Percy H. Fridenberg¹¹ has even suggested that "as normal labyrinths merely support the possibility of vertigo and false sensations of direction and space, one might even venture the paradox that the safest aviators would be those with dead labyrinths."

*From the Psychology Laboratory of the Johns Hopkins University.

It has frequently been reported that deafmutes with congenitally defective vestibular apparatus enjoy immunity to seasickness and are not subject to the troublesome after-rotation effects so often experienced by amateur acrobats and whirling dancers and by other novices in the art of prolonged bodily rotation. These facts together with the objectionable vestibular effects frequently experienced by aviators seem to have convinced Dr. Edmund Hobhouse¹⁵ that ". . . we are driven to the somewhat painful conclusion that in the semicircular canals man possesses a beautiful and complex mechanism which has been superseded by higher development, and whose only positive function now is to produce some of the most disabling and distressing symptoms which the human body can experience; moreover, this mechanism is so bound up with the organ of hearing that it is impossible to remove it without inflicting the penalty of deafness."

This deprecating view of the fundamental functional utility of the semicircular canals is either explicit or implied in the writings of a number of authors besides Dr. Hobhouse, and seems to be at least in part, the outgrowth of the widespread acceptance of the assumption that prolonged bodily rotation constitutes the method by which the canals are normally stimulated and that the effects thus produced—nystagmus, vertigo, nausea, etc.—are normal and invariable responses, which can in no way be eliminated or reduced so long as the vestibular mechanism retains its functional integrity. Dr. Lewis Fisher,¹⁰ one of the more ardent protagonists of this point of view, writes as follows:

" . . . The method we employ in the examination of this special sense is the same applied in the study of the other special senses, that is, we try to imitate their respective physiology. If, for instance, we wish to examine the taste sense, we put on its end organ, the tongue, a substance which is physiologically interpreted by the normal individual as bitter, sour or sweet, as the case may be. In the same way, in the examination of the notion sense, we try to imitate under our guidance and direction its physiologic function and see if it accords with the normal."

"It must be taken for granted that normal special sense mechanisms must produce normal responses. Examination of more than one hundred thousand normals (by the rotation tests) has demonstrated that ear stimulation invariably produces nystagmus and vertigo. When upon similar stimulation these phenomena do not occur it definitely indicates a pathologic disturbance at some portion of this mechanism."

If "nystagmus and vertigo" are indeed the "normal responses" to normal "physiologic" vestibular stimulation, it might readily be inferred that the whole vestibular mechanism* is biologically archaic and may be dispensed with quite advantageously. This, it seems, is precisely the conclusion of a rather large number of writers. However, such a deduction can scarcely be regarded as valid, because of the very dubious character of the premises upon which it is based.

In the spontaneous, natural activity of most living organisms, and certainly in the case of man, rotatory movements, either of the body as a whole or of the head alone, are ordinarily of relatively short duration and small magnitude, and the resulting vestibular stimulation correspondingly brief. Regardless of whether the conventional hydrodynamic theory (inertia-momentum movements of the endolymph) is accepted, the fact remains that it is angular acceleration and retardation, and not rotation *per se* which constitute the efficient mechanical factors in the stimulation process. Moreover, the nystagmus and other compensatory responses produced by acceleration are diametrically opposed to those produced by retardation. Therefore, when acceleration and retardation occur in such close temporal sequence as is usually the case in normal body movements, the effects produced by the former almost immediately cancel and are canceled by the effects of the latter so that there is effective stimulation (and therefore response) only during the brief acceleration-to-retardation interval, with no discernible after-effects. However, when the organism is continuously rotated for 20 seconds at the rate of one revolution in two seconds (the orthodox clinical prescription), the acceleration and retardation are so remote from each other temporally that the acceleration effects will have largely or perhaps entirely disappeared before the onset of retardation

*S. S. Maxwell,²¹ R. L. de N6,²² and others have shown that the traditional view of the semicircular canals as exclusively "dynamic" receptors and of the otolithic organs as exclusively "static" receptors is, in the main, unwarranted. It is now clear that the entire vestibular system functions more or less as a unit; statements cannot be made, therefore, about the functional utility of the semicircular canals without also including the sacculus and the utricle—consequently the expression, "whole vestibular mechanism."

so that the effects of the latter are left uncanceled and produce violent and entirely mal-adaptive post-rotation responses. The situation is, of course, fundamentally similar when rotation is incurred by aeroplane stunting, dancing, fancy skating or by any other method involving continuous and prolonged turning of the entire body. It would appear, therefore, that all that may be safely inferred from the results of prolonged bodily rotation, however produced, is that abnormal vestibular stimulation produces abnormal responses, a conclusion which by no means warrants the assumption that the vestibular mechanism has no biologic utility and may be advantageously extirpated.*

Another source of confusion is the contention of Jones and Fisher,¹⁹ as well as numerous other writers, that ". . . nystagmus and vertigo are distinct and separate phenomena and . . . are not in any way dependent on each other." Jones and Fisher assume, of course, that these two phenomena are related in that they have a common origin, namely, vestibular stimulation; but they are insistent on the point that vertigo and nystagmus ". . . are different reactions produced by stimuli sent along (!) entirely different paths." Bárány,¹ Sanford,²⁵ Holt¹⁸ Dunlap,⁶ Griffith¹³ and others have advanced considerations which strongly suggest that vertigo (defined as the illusory rotation of the visual environment or of the subject's own body), and perhaps even the incidental nausea are not the results of direct vestibule-to-brain impulses, as Jones and Fisher believe, but are the consequences of the visual and kinesthetic stimulation resulting from the vestibularly produced nystagmus. If this is true—and there is every indication that it is—then it would seem that it is merely the vestibulo-ocular reflexes involved in the production of nystagmus, and not the vestibular reaction system as a whole, which are to be held

*The writer does not intend to imply that the Bárány rotation tests and the various American modifications of them (however unsuited they may be for determining the specific qualifications of aviators) are useless in clinical diagnosis. The use of abnormal (i.e., unnatural) forms of stimulation is an entirely legitimate method in other branches of clinical inquiry, and there is no reason why it should be excluded from the otological clinic. The writer's suggestion is merely that both the stimulation and the responses produced by the rotation tests, as well as those produced by other types of prolonged rotation, are abnormal and should be frankly acknowledged as such.

responsible for the objectionable after-effects of prolonged bodily rotation and of other unusual types of vestibular stimulation.

Pike²⁴ has comprehensively reviewed the effects of both experimental and accidental labyrinthectomy; and his findings indicate that whatever special advantages (immunity to seasickness, absence of the after-effects of rotation, etc.) may accrue from the ablation of the vestibular apparatus, the resulting disadvantages are for more consequential. Severe abnormalities in muscular coordination and tonicity, general disturbances of equilibration and locomotion, to say nothing of the more subtle psychologic effects, are the characteristic and more or less permanent results of such injuries. There is, to be sure, some recovery, but the vicarious functioning of other sensory mechanisms (vision, touch, kinesthesia, etc.) is never completely adequate—a fact which would seem to constitute a reliable indication that the vestibular mechanism as a whole is of genuine biologic importance and cannot be dispensed with without serious disability to the organism.

Although the fundamental utility of the vestibular apparatus must, apparently, be taken for granted, the specific and normal function of the various vestibulo-ocular reflexes,⁸ however, has not been made entirely clear. Since it is these reflexes, as pointed out above, which probably constitute the major source of the distressing and mal-adaptive phenomena which have prompted the skepticism concerning the importance of the entire vestibular system, this becomes an exceedingly vital point. Unfortunately, previous investigators of the vestibular eye reflexes have usually employed either galvanic, caloric, rotational, chemical, surgical, mechanical or some other artificial form of stimulation,¹² and the responses obtained have been correspondingly artificial and unindicative of the real purpose of the underlying mechanisms. A far more promising approach to the problem seems to lie in the direction of the study of these reflexes as they occur during normal bodily activity.

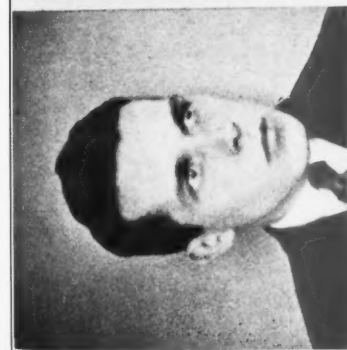
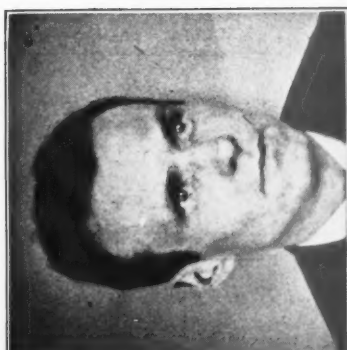
In a recent paper Dunlap and Mowrer⁷ reported the satisfactory use of motion pictures as a means of analyzing certain visual and vestibular responses in birds. This suggested that a similar technic might be profitably employed in studying the vestibulo-ocular reflexes in humans. Accordingly an experimental situation

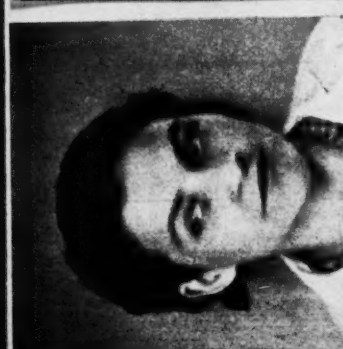
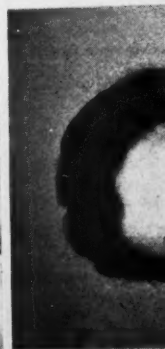
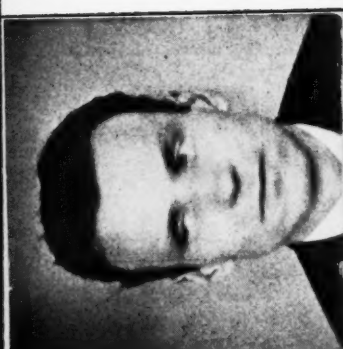
was constructed in which the subject sat four feet directly in front of the motion picture camera, which was flanked on either side by a Cooper-Hewitt mercury-vapor arc light to supply illumination. Somewhat nearer the subject, at the level of his eyes, were located two low intensity frosted electric lamps, one 45 degrees to his right and the other 45 degrees to his left. The subject was instructed to look at whichever lamp happened to be on at a given moment. By means of a suitable double-pole switch it was possible for the experimenter to alternate the light in the two lamps at will and thereby to cause the subject to look now from right to left, now from left to right, in a quite normal fashion. A certain amount of practice in looking back and forth as the lights alternated was given each subject before any pictures were taken, but in no case was any suggestion made as to what was the purpose of the experiment. In all, ten young adult subjects were photographed, and six or eight movements of the head and eyes recorded for each subject. The accompanying illustration shows a single excursion of the head and eyes from left to right for each of four subjects.

In taking the pictures the camera was operated at the rate of sixteen exposures per second. Therefore, since the pictures in each of the descending columns in the illustration are enlargements made from successive frames in the movie reel, it is possible to obtain a fairly accurate notion of the time relations involved. On this basis it will be noted that the time required for the eyes to shift from one light to the other (an angular change of approximately 90 degrees) is something less than two-sixteenths of a second. On the other hand, the time required for the head to make a rotatory movement of approximately the same angular magnitude is roughly five-sixteenths of a second. This greater mobility of the eyes is unquestionably a decided advantage from the point of view of visual efficiency and was likely evolved for this reason; however, in giving the individual the ability to rotate the eyes in their sockets independently of the head, nature created another problem, namely, that of preventing head movements from causing eye movements. Reference to the illustration will show that by the time the third picture in each column was taken the eyes had completed their excursion

but that the incidental head movement was in each of the four individuals less than half completed at this point. It will also be noted that the head movement was not completed until the sixth or bottom picture was taken, that is to say, the head continued in motion approximately three-sixteenths of a second after the eyes had attained their goal. In such cases if the eyes are not to be carried past the desired point of fixation by this motion of the head, it is obvious that the left horizontal rectus muscle of each eye must contract somewhat and the right horizontal rectus muscles relax proportionally. By this type of compensatory adjustment the eyes can maintain their visual fixation while the head is still in rotation. It is known, moreover, that the vestibular stimulation resulting from rotation of the head clockwise (i. e., to the subject's right) produces precisely the changes in the eye muscles which would be required for efficient compensation of this sort, and that rotation of the head in other directions produces changes in the eye muscles which are correspondingly appropriate for the maintenance of the existing fixation.²² These facts strongly suggest, therefore, that the normal physiologic function of the various vestibulo-ocular reflexes is to prevent the eyes from moving with the head and to assist them in maintaining whatever point of fixation may have been selected by the previous and more rapid voluntary movement of the eyes themselves. Consequently, whenever the circumstances are such that these eye reflexes do not perform this function but instead give rise to vertigo and other mal-adaptive effects, either the conditions of stimulation must be regarded as essentially unnatural or the subject himself as pathologic. This, it may be said, is not a strictly original conception (cf. Breuer,² Brown³ and Koenig²⁰); however, it is one which has been badly neglected, and is greatly in need of emphasis.

One may readily convince oneself of the remarkable efficiency with which the various vestibulo-ocular reflexes perform the function outlined above by completely abandoning all voluntary control of the eyes and oscillating the head in any plane or combination of planes. It will be noted that whatever point of fixation has been assumed at the beginning of oscillation will be maintained automatically until the eyes are again moved voluntarily,







Enlargements made from successive frames of a 16 mm. motion picture film, showing the relationship between normal eye and head movements.



and that under these as well as the more usual conditions of head movement there is never the slightest apparent movement in the visual environment (except that occasioned by parallax), thereby indicating the complete adequacy of the compensatory action of these vestibular reflexes.*

Quite aside from the considerations already mentioned, there is still another advantage in having a reflex mechanism for preventing the eyes from moving uniformly with the head. E. B. Holt¹⁷ and others have suggested that during the greater part of ordinary saccadic movements the human eye is quite blind. Presumably this momentary visual anesthesia, if it actually exists, is produced by some central inhibitory or deflective mechanism and has as its function the elimination of vision at those times when the images on the retinae are unavoidably in rapid motion. In contrast to Holt's central hypothesis, Dodge⁴ has emphasized a peripheral mechanism by which blurred vision is eliminated during the saccadic movements. The merits of these two hypotheses cannot be pertinently discussed here; however, suffice it to say that on the basis of either theory it is regarded as essential that the eyes move to successive fixation points with great rapidity. If the eyes were allowed to rotate with the slower angular velocity of the head, both explanations would be inapplicable and the subject would presumably experience at such times a confusing whirling of the entire visual environment.

If the above observations and interpretations are correct, then the so-called vestibular apparatus is of fundamental biologic utility in man as well as in the lower vertebrates and, at least at the present stage of evolution, cannot be parted with without serious organic disadvantages. Moreover, even the vestibulo-ocular reflexes, although patently responsible for vertigo and perhaps also for nausea under abnormal conditions of stimulation, are highly useful responses under ordinary conditions of life. That individuals without these reflexes manage to compensate for their loss

*That the fixation of the eyes in such cases is not preserved by retinal-ocular reflexes has been established to the writer's own satisfaction by the use of the string galvanometer; this instrument shows that the compensatory reactions of the eyes to head rotations is quite as adequate when the eyes are closed as when they are open.

with a fair degree of efficiency by no means proves that these responses are not of very great service to the normal individual. Reason for denouncing the vestibulo-ocular reflexes is still further reduced by the experimental findings of Dunlap,⁵ Griffith¹⁴ and Holsopple,¹⁶ who have demonstrated that the reputed advantages to be derived from the absence of the vestibular apparatus may indeed be acquired by a suitable process of habituation and that the supposedly "invariable" and certainly very disagreeable consequences of prolonged bodily rotation and other forms of artificial vestibular stimulation may be largely, sometimes entirely, eliminated without incurring the obvious disadvantages of labyrinthectomy or of congenital labyrinthine defect.

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XXXIII.

LARYNGITIS AND TRACHEOBRONCHITIS IN CHILDREN: SPECIAL REFERENCE TO NON-DIPHTHERITIC INFECTIONS.*

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Laryngeal and tracheobronchial infections in infants and young children are often very serious conditions. The mechanical obstruction of the air passages adds a much greater hazard at times than does the infection itself. For many years diphtheria has been quite universally blamed for practically all cases of laryngeal dyspnea of infectious origin. In 1920 we realized for the first time that there were nondiphtheritic infections of the larynx, trachea and bronchi in which the onset and symptoms simulated diphtheria, but in which antitoxin gave no relief and mechanical obstruction below the canula was decidedly more troublesome than in true diphtheria. Our first three cases of this disease, occurring in 1920 and 1921, terminated fatally. As these nondiphtheritic infections continued to appear, more active measures were taken to keep the trachea and bronchi free from discharge and semi-solid plugs after tracheotomy, and our mortality decreased. It has remained consistently higher, however, than in cases of true diphtheria, despite continuous efforts to combat the added difficulties.

In 1926, before the American Laryngological, Rhinological and Otological Society, I discussed this same subject; reviewed the American literature for twelve years; quoted from some fourteen references; and reported fourteen cases from our own private practice. At that time I emphasized that attention was not being called to a rare or new condition, but there was reason to believe that many of the nondiphtheritic cases were being handled as diphtheria, and classified as such in mortality and health statistics.

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Communications from health authorities of many of our larger cities as well as a review of the literature confirmed that belief. It was very evident that statistics relating to the efficacy of toxin-antitoxin as a preventive and of antitoxin as a curative agent were being influenced decidedly by wrong diagnoses of the infectious agents responsible for the clinical picture.

Since 1926 I have kept a fairly close check of the literature concerning this disease, and have noticed in almost every report the notation that these nondiphtheritic infections of the larynx, trachea and bronchi were very rare. A goodly number of reports of cases and papers have appeared. Almost invariably the writers have called attention to the lack of reference in the literature to similar cases. Quite often, only three or four references appeared in the bibliography, and these referred to textbooks or articles in local state and sectional journals. Three papers from one small locality were found wherein one or more cases were reported. The bibliography of each paper included only the references to the other two. All three articles appeared in issues of the same sectional journal. One writer described a single case with a typical clinical picture of nondiphtheritic infection as atypical diphtheria, but hastened to add that the course was so typical of diphtheria that no culture was taken. Hasty scanning of a few journals on the writer's desk and perhaps some textbooks often bring forth the comment that the condition under discussion must be rare and the literature scanty. My only excuse for calling attention again to these nondiphtheritic infections of the air passages is to emphasize that, in relation to other conditions causing serious dyspnea, they appear not occasionally but often, and when they do appear they may present very serious problems. The mortality rate is still very high, even when the condition is recognized early and all known treatment is carried out.

Our experience with this condition emphasizes that the diagnosis of serious dyspnea is the important thing, regardless of the cause. Valuable time is often wasted waiting for the action of antitoxin, for bacteriologic findings or X-ray reports. It is the opinion of some very good observers, with whom I agree, that entirely too much importance has been given to the thymus in relation to dyspnea and sudden death. It assumes an active imag-

ination to attribute sudden fatal compression of a firm cartilaginous larynx and trachea by a relatively soft lymphatic structure. That sudden cardiac deaths do come in infants with an enlarged thymus and so-called lymphatic diathesis is not disputed, but they also appear from simple incision of retropharyngeal abscesses and other minor procedures when the thymus is apparently normal. Dyspnea is a serious condition, especially in infants and young children, and must be relieved early to save life, regardless of the cause. Spasmodic types not due to infection are not considered here, though naturally some of them need emergency cannulation to save life. In such cases the emergency is always recognized, at least, even if relief is not given in time. In the infectious cases the dyspnea is often much more gradual. Real cyanosis may never appear, but instead a pallor or pale cyanosis due to physical and cardiac exhaustion. This dyspnea that goes on for hours without sudden obstruction or blue cyanosis is the dangerous type, because procrastination is easy. Watchful waiting in exhaustive dyspnea often is considered conservative treatment, though actually such procedure is extremely radical. Obstructive breathing that goes on for hours, especially if it continues during the daytime, needs very careful watching and usually cannulation, especially if there is marked restlessness, fluid refusal, pale cyanosis and weak pulse. Dangerous symptoms develop in inverse proportion to the age of the child. Hoarseness may appear early but may not be pronounced in severe cases, because the obstruction is often subglottic and tracheal. Often the true cords are only slightly thickened with no membrane. Cough may be dry or absent, giving the impression that no secretions are present in the trachea, though at the time of tracheotomy much thick discharge is encountered. This lack of cough reflex naturally adds greatly to the dangers, especially in the younger children.

The severity of the dyspnea, and often the seriousness of the illness, has no direct relation to the type of organism found. The preceding respiratory infection may be very mild with little evidence of toxemia. Mechanical obstruction of the airway often creates a serious condition, though the actual infection is a mild one. Adults in the same family may be suffering from laryngitis with only a slight hoarseness and morbidity, yet infection of a

child with the same organism may create a serious condition. Naturally, the severity of the mechanical obstruction is influenced by the age of the child. The small larynx with the larger amount of lymphoid tissue spells disaster to the infant at times, when the organism is only mildly virulent and the tissue reaction is moderate.

In our experience, the onset of laryngeal symptoms is usually preceded by a few days or a week of generalized respiratory infection. In two of our cases the laryngeal trouble followed measles, but we have had no experience with the epidemic type mentioned by some writers. During the course of any acute respiratory infection hoarseness and croupy cough appears. A goodly number of patients naturally do not develop any more serious symptoms, and may get well with no evidence of real dyspnea. As mentioned previously, it is the difficult breathing with supra- and infra-sternal and intercostal retraction that usually commands attention and demands relief. Hoarseness and cough may be mild or severe with no direct relation to the amount of dyspnea. Restlessness, fluid refusal, and pale cyanosis present a clinical picture which needs very careful observation and usually cannulation before physical and cardiac exhaustion has become serious. Some of the very sick patients may have pneumonia even before dyspnea develops. Naturally these are serious cases, regardless of what treatment is used.

At the time of tracheotomy the most characteristic finding in almost all cases has been the thick, tenacious secretion in the trachea, with usually only moderate swelling of the mucosa, some exudate, but practically never a real membrane. In some instances there was practically no liquid discharge, but rather semisolid plugs of brownish material in the trachea and bronchi. As a rule, dyspnea is relieved quickly and color returns very soon after tracheotomy and removal of secretions, either by cough or suction. Within twelve to twenty-four hours after tracheotomy there is very often a high temperature, even when there has been very little elevation during the previous course. At the same time there is usually a marked dryness of the air passages. There may be no cough and no secretions removed from the tube by suction. Breathing may be rapid and shallow and pulse and color poor.

At such a time it is very easy to attribute these symptoms to toxemia rather than obstruction, and this we did in the earlier cases. During this dry stage, weak adrenalin or saline solution dropped into the tracheotomy tube helps to liquefy secretions and allow their removal by suction. Cough reflex is stimulated with removal of plugs and a decided improvement in the breathing, pulse and general appearance of the patient. In severe cases this treatment is used at regular intervals, day and night, and we feel sure that several of our cases which recovered would have died without it. Such a dry stage with the high fever, etc., is not often encountered in real diphtheria. Therefore, it is the most important part of the clinical course to emphasize. Naturally, some of the cases will die of severe toxemia from pneumonia or tonsil infection in spite of any treatment of the tracheobronchial tree, but there is no doubt that many fatalities result, because this simple treatment for relief of mechanical obstruction is not carried out early and consistently. In a few instances the bronchoscope has been needed to remove some of the semisolid plugs from the trachea and the openings of the large bronchi. In the last few years, when we have used suction early and often in conjunction with adrenalin or saline, it has not been necessary to resort to bronchoscopy. It is our belief, after watching these cases for twelve years, that most of our fatalities now are due to pneumonia. Where pneumonia is not present and does not develop, we feel quite confident of saving these patients if seen reasonably early.

The general treatment, especially keeping up the fluid intake, is probably second in importance to tracheotomy and removal of secretions by suction. It is our belief that intravenous saline in large quantities plays a great part in liquefying the secretions in the air passages and helping to tide over the dry obstructive stage. It is very dangerous in the serious cases to expect enough fluids to be taken by mouth or rectum. Various medicines, iodides, etc., have been given with the hope of some action on the bronchial secretions, but we feel quite sure that ordinary fluids in large amounts are much more valuable.

To understand more clearly what happens in the serious cases, more thought must be given to the diagnosis of obstructive dysp-

nea. In laryngeal obstruction the retraction of the supra- and infra-sternal and intercostal spaces with cyanosis makes the diagnosis self evident. The lower down the obstruction is in the air passages the less external evidence there is of dyspnea. When the bronchi are obstructed, there is naturally no reason for the patient to use the extrinsic muscles, and the breathing may be very quiet and shallow. It is during this stage that mechanical obstruction is such a serious condition, because it is usually not recognized as such, and the poor condition of the patient is attributed to toxemia. It seems likely that many children with serious so-called bronchopneumonia but with none of the usual evidences of high air passage obstruction could be saved if secretions were removed by bronchoscopy or tracheotomy and suction. In other words, because these patients have no evidence of laryngeal obstruction, dyspnea is not considered. The pallor, high temperature, weak pulse, etc., are attributed entirely to the severity of the infection. It seems reasonable to assume that many cases of bronchopneumonia have the same physical findings that we encounter in these nondiphtheritic infections, and they differ only in that no laryngeal obstruction preceded or accompanied the lower air passage obstruction. Experience with foreign bodies in the air passages has naturally tended to add some weight to the statements just made.

REPORT OF PERSONAL CASES.

Our experience with nondiphtheritic infections of the larynx and tracheobronchial tree has included a study of twenty-four cases since 1920. These patients have appeared in the private practices of my associate, Dr. J. B. Naftzger, and myself. In fifteen of these cases tracheotomy was done. The other nine had dyspnea of enough severity to demand hospital observation and treatment. They were constantly under observation, with the idea that tracheotomy could be done on short notice. Treatment in these milder cases included croup tent, steam inhalations, and especially high fluid intake. Fluids were forced by mouth, if necessary also per rectum, and in a few cases were given intravenously. In the nine cases without tracheotomy, one patient (a baby four weeks of age) died. This patient, however, was not in our service and we saw it only when it was in extremis. The

mechanical obstruction in this instance seemed of lesser importance than the toxemia from pneumonia. As mentioned above, fifteen of the cases had tracheotomy. Seven of these recovered and eight died, a mortality of 53 per cent in tracheotomized cases. The first three of this group were seen in 1920 and 1921, and all died. Autopsy was obtained on the first case in 1920. The larynx and tracheal mucosa was covered by a thin exudate or pseudomembrane. There was almost complete obstruction of the main and smaller bronchi by thick, brown, sticky material made up of fibrin, leucocytes, epithelial cells and organisms. There was no evidence of pneumonia. From 1922 to 1926 there were seven cases, of which four recovered and three died. From 1926 to 1932, there were five cases. Three recovered and two died.

As these statistics indicate, our mortality has remained very high, even during the years that we have watched these cases carefully, have recognized their real nature early, and have tried every known method of treatment. Removal of secretions by suction through the cannula, with the help of normal saline or adrenalin, has been the prominent factor in keeping the mortality rate from being higher. For years every case has been in the hospital under observation from the time we have first seen it. If tracheotomy was done in the home the patient was removed to the hospital for treatment. Of course, the mortality does not seem so high when we consider the entire group, including the nine cases which did not have tracheotomy, because then we find that fifteen recovered and nine died, a mortality of 37 per cent.

It might be of interest to note that during the same number of years that we encountered twenty-four cases of nondiphtheritic infection there were seventeen of true laryngeal diphtheria. In the seventeen cases, sixteen had tracheotomies. Of this group, ten recovered and six died, a mortality of 37 per cent, as against 53 per cent in similar nondiphtheritic cases.

Since 1920, we have encountered one or more serious nondiphtheritic cases each year, and as a rule there has never been more than one under treatment at the same time. In other words, in our experience there has seemed to be no grouping in families or localities indicating an epidemic condition. Our experience

with true laryngeal diphtheria has been decidedly the opposite. In 1923 we had five cases which needed tracheotomy. From 1923 to 1926 there was but one such case. From 1926 to 1929, one more. Then in twelve days of December, 1931, we had four. In other words, we had more serious laryngeal diphtheria cases during twelve days of one year than we had in the entire six previous years.

As is evident from the above statistics, tracheotomy is our choice at all times with these nondiphtheritic cases if cannulation is needed. In a few of the earlier cases intubation was tried, but we feel that it is a dangerous procedure in most instances. Cultures were taken in all the twenty-four cases direct from the larynx by laryngoscopy and also from the trachea when tracheotomy was done. The laboratory reported these cultures positive for various types of streptococci and staphylococci in pure or mixed cultures. At times pneumococci were mentioned along with a few influenza bacilli. In three of the cases bacilli resembling K.-L.'s were found, but the predominating organisms were either streptococci or staphylococci. In these three patients the symptoms and clinical course following tracheotomy and antitoxin, as well as the appearance of the larynx and trachea, were so typical of nondiphtheritic infection that we felt the few K.-L. bacilli found were probably incidental. We all know that many apparently normal throats will show bacilli, at least resembling K.-L.'s, when no clinical symptoms are present. It seems very likely then that a few diphtheria bacilli found in culture may lead to the diagnosis of diphtheria when the predominating organisms are streptococci or staphylococci, and the symptoms are caused by these latter organisms. Laboratory study of the organisms has been important in our experience only in deciding between diphtheria and some type of nondiphtheritic infection.

General considerations have been given above. To add emphasis to certain statements, the material will now be abstracted under subtitles. Repetition is intentional to stress what seem to the writer to be important points.

INCIDENCE.

As mentioned above, we have cared for twenty-four cases of nondiphtheritic laryngitis and tracheitis since 1920. All of these

cases were of such severity as to be in the hospital under treatment, and fifteen had tracheotomies. In going over the literature on the subject, references to similar cases were found as far back as 1915. Naturally we must assume that we have always been dealing with this condition, but it has probably been confused with diphtheria and still is. The bibliography of this paper contains about thirty-five references. From one to twenty-four cases have been reported by each writer. In our experience, this disease has not assumed any epidemic importance and contact cases have been rare. Some writers have described epidemics with long periods of freedom in their localities. In one report, two brothers and a cousin were affected; in another, three children in the same family developed serious trouble within four days' time. Measles has been mentioned as preceding a number of these nondiphtheritic infections. One writer had five cases in one month, in which the staphylococcus albus in pure culture was obtained from the tracheal exudate. Personal communications from heads of various public health departments in our larger cities indicate that many more cases of this type are reported and treated as diphtheria than one would suspect. The head of the health department in one of our large cities reports that statistics there show 3 per cent of all children have diphtheria-like bacilli, although these organisms may play no part in the disease under investigation. It is the experience of many men in health work that the greater tendency is to diagnose diphtheria in cases which are not diphtheria, rather than the opposite.

SYMPTOMS.

Laryngitis and tracheobronchitis of nondiphtheritic origin appear usually in the course of ordinary respiratory infections. Hoarseness and cough may precede by hours or days the development of dyspnea. The onset usually simulates that of laryngeal diphtheria. Following intubation or tracheotomy, there is a decided difference in the clinical course of the two diseases. The mechanical obstruction below the cannula in the nondiphtheritic cases usually continues to be a serious problem for days or even weeks. There is a tendency for thick discharge or sticky brownish secretion to form in the trachea and bronchi below the cannula and obstruct the lower air passages. If this obstruction occurs

low in the bronchi there may be no evidence externally of dyspnea, and the severity of the symptoms is often attributed to the toxemia rather than to the obstruction. Pneumonia is a serious complication and may appear before, during or after the obstruction in the air passage develops. At times, of course, the removal of secretions from the trachea and bronchi has no effect on the pneumonic process or clinical picture. In other instances, however, the high temperature, poor pulse and color, and other symptoms attributed to pneumonia may disappear rather quickly after removing secretions by suction. Naturally some cases are mild and the dyspnea does not become severe enough to warrant intubation or tracheotomy. It is dangerous, however, to trust these cases outside a hospital, because serious symptoms may develop very rapidly.

DIAGNOSIS.

Diagnosing the severity of the dyspnea is of much more importance than determining the causative organism. Waiting for culture reports, giving antitoxin hopefully, X-raying the thymus or chest before relieving the dyspnea may allow physical and cardiac exhaustion to bring on a fatal result unnecessarily. The larynx is always examined with the laryngoscope and cultures taken. The possibility of foreign body is always kept in mind. In nondiphtheritic infections, the edema and inflammatory swelling, especially below the cords, is usually pronounced, with possibly no membrane, but often a thin exudate. The true cords may be only slightly swollen and reddened, thus explaining the moderate hoarseness in some cases. As a rule, the subglottic swelling causes the severe obstruction and does not allow a view of the trachea without trauma. At times a thick gray membrane closely resembling that found in diphtheria may be present. A staphylococcus has usually been reported as the predominant organism when a real membrane was encountered. Antitoxin has been given almost routinely in the cases under our observation before the culture was received, even when we felt quite sure we were not dealing with diphtheria. We have felt that possibly there would be a beneficial foreign protein reaction, even when there was no specific action expected.

TREATMENT.

From our experience with nondiphtheritic infections of the larynx and trachea, we feel that all infants and young children with dyspnea that lasts for several hours, especially when it continues in the day time, should be in the hospital under constant observation and treatment. In the milder cases, croup tent with steam inhalations; possibly iodides and forced fluids by mouth, rectum or intravenously are of great importance. If dyspnea is present of sufficient severity to cause supra- and infra-sternal and intercostal retraction, especially if this has gone on for many hours and there is also pale cyanosis indicating physical and cardiac exhaustion, then tracheotomy should be done. We prefer and advise tracheotomy in the type of case under discussion rather than intubation for various reasons as follows:

1. An intubation tube, even though it gives quick relief, may come out at any time and thus a new emergency is created, possibly more urgent than that previously encountered. A tracheotomy tube, we know, will stay in place. Unless there is a trained physician at all times in the hospital to replace an intubation tube, it is dangerous to trust this procedure. Patients will be lost after tracheotomy, but not because of laryngeal or upper tracheal obstruction. The intubation tube should be classed with the bronchoscope as a life-saver in emergency, but should not be trusted for after-treatment. In the condition under discussion tracheobronchitis may be as serious as the laryngitis and may need as much attention.

2. If an intubation tube has to be replaced several times in a larynx, or if it has to remain longer than three or four days, it is very possible that damage to the mucosa may result in a stenosis later. In these nondiphtheritic cases the canula must remain in place often much longer than in diphtheria. Some writers have reported the tubes in place for four weeks. In our experience, eleven days has been the longest time cannulation has been necessary. Tracheotomy when done properly will have no bad effect on the larynx and cause no fear of stenosis later. It seems unreasonable that the organ of speech should be deliberately traumatized to obtain the same result which will follow an opening into the trachea, which is certainly not a highly specialized organ.

And is it not proper that we give up discussing high and low tracheotomies? There should be no such thing as a high tracheotomy through the cricoid or the first or even second ring of the trachea in laryngeal and tracheal infections only as a mistake or an accident.

3. In practically every case of nondiphtheritic infection and often in true diphtheria, for that matter, thick discharge or sticky exudate has been encountered in the trachea at the time of tracheotomy. It is unreasonable to expect relief of dyspnea unless this membrane or discharge is removed. It is a difficult matter to remove this through an intubation tube, especially in infants and small children where the cough reflex is not active. At times emergency dyspnea is produced by membrane pushed ahead of either an intubation tube or a bronchoscope. One writer, after reporting a large series of these nondiphtheritic cases, advises intubation at first rather than tracheotomy, because he feels there is more tendency for the secretions in the trachea and bronchi to become dry when the air passes directly through the tracheotomy tube. He mentions that after the dry stage of tracheitis has passed, tracheotomy may be substituted for intubation. In our experience the thick discharge encountered at the time of tracheotomy has argued against the rationality of the above procedure. There is a dry stage beginning twelve to twenty-four hours after tracheotomy, but frequent instillations of normal saline or weak adrenalin solution into the cannula to allow suction treatment has helped remarkably in handling the condition at this stage. In many of these cases the cough reflex is entirely subdued during the serious stage, and it seems to us very reasonable that to get access to the trachea to liquefy and remove secretions is of utmost importance.

4. Against tracheotomy it may be said that it is an operation and should not be classed with intubation as an emergency procedure. There is the possibility of more shock and hemorrhage and possibly emphysema of the tissues of the neck. It is common knowledge, however, that the only complications worthy of note following tracheotomy have been due to faulty technic in opening the cricoid or first ring of the trachea. Low tracheotomies have been done as emergency procedures under all types of

working conditions, by men of all degrees of skill, and still the complications have been very few and unimportant. Stenosis of the larynx in infants and young children is certainly a very serious condition to handle. We know that it may follow intubation even when done expertly if the tube has to be replaced often or left in place for a long time. Stenosis of the larynx will never follow as a direct result of tracheotomy properly performed. Suction directly through the tracheotomy tube early and often to remove free discharge, with the help of normal saline or weak adrenalin solution during the dry stage is practically specific and often life-saving in serious nondiphtheritic infections. Our first three cases of this type of infection died, and we feel quite sure they were fatalities because no efforts were made to remove secretions from the lower trachea and bronchi. We have lost a number of cases since this treatment was adopted, but we have saved several that we feel sure would have died without it. In several instances a bronchoscope was needed in emergencies to remove some of these plugs from the bronchi which would not dissolve to be removed by suction. The necessity for use of suction and liquefying agents does not depend upon the usual signs of dyspnea. This point cannot be emphasized too often. Obstruction in the lower trachea or bronchi does not call into play the extrinsic chest muscles. In fact, the breathing may appear perfectly quiet and very shallow with the bronchi almost obstructed.

Fluids play a prominent part in the treatment, as previously mentioned. It is impossible in many infants and children during the active dyspnea to get enough fluids by mouth or even by rectum. Intravenous saline is a great help both in liquefying the bronchial secretions and improving the general condition.

We have used antistreptococcic serum in some cases, and others have advised it, as well as pneumococcic serum. One writer suggested diathermy to the chest. Another feels that sodium bicarbonate in large doses is advisable. Sedatives are mentioned simply to condemn their use. To use them will only mask the important symptoms and interfere with the important action of the extrinsic muscles. The oxygen tent is certainly of distinct value in these cases, and wherever it is available it should improve the prognosis greatly. Local treatment of the larynx has been men-

tioned in the literature as of some avail in certain cases. In our experience, it has only increased the dyspnea to irritate the larynx through the laryngoscope or by passing the bronchoscope. Even in cases where thick membrane can be removed with marked improvement in breathing, this procedure may promote a false confidence. The relief from dyspnea may be marked, but only temporary, and an emergency may develop at any time. One writer mentions the possibility that immune blood is of some advantage.

BACTERIOLOGY AND PATHOLOGY.

The obstruction in the larynx is usually greater in the subglottic region and is due to swelling of the tissues rather than to membrane or exudate. The true cords often are not badly swollen, but at other times may be inflamed and edematous. Occasionally an acute edema of the laryngeal tissues has developed rather suddenly in addition to the inflammatory swelling. In the trachea there is usually thick discharge, sometimes brownish in color, which tends to form in sticky layers on the tracheotomy tube or bronchoscope. When the trachea is first opened, this brown sticky secretion is less evident than twelve to twenty-four hours later when the temperature has risen. Plugs removed from the trachea or bronchi when examined have been made up of fibrin, leucocytes, epithelial cells and organisms. At autopsy the smaller bronchi have been found practically blocked by these thick sticky plugs. Membrane of a type found in diphtheria is practically always absent. A thin white pseudomembrane or exudate is often present.

The culture report mainly distinguishes diphtheria from these nondiphtheritic infections. Streptococci, staphylococci, pneumococci and influenza bacilli have been found in our cases and reported in the literature in pure or mixed cultures without anything in the appearance of the larynx or trachea, or in the clinical course, that is suggestive of any one organism. Streptococci have been named in more reports of these cases than the other organisms, but in several cases staphylococci have been mentioned as the only organisms found. In our experience, it has been very rare to find anything but a mixed infection with one or other of these organisms possibly predominating. A detailed cul-

tural study of the organisms of one patient (a child of twenty months) is of some interest because the same type of streptococcus was isolated from the larynx of the mother of this child. She had been suffering from an acute laryngitis of a mild type, with some hoarseness and cough for three days before the child developed dyspnea. The mother was never in bed and had practically no trouble, while the child had a stormy time. The organisms from both patients were studied very carefully on various types of media and were found to be identical in all cultural characteristics. It seems then that the only thing of importance about the bacteriology of these cases is to prove that they are nondiphtheritic. The treatment as a rule is the same, regardless of the organism found.

PROGNOSIS.

Dyspnea is always serious if continued, and especially so in the very young patient. If this dyspnea is long continued, physical and cardiac exhaustion may cause a fatality before the obstruction is relieved by cannulation. Temporary relief of the dyspnea by intubation or tracheotomy may be followed by recurrence of serious symptoms, if proper treatment is not instituted. Mechanical obstruction rather than toxemia is of greatest importance in most instances, and decrease in mortality depends on active results to relieve it. Pneumonia, broncho or lobar, may come on before treatment or after serious dyspnea develops, and its severity may of course determine the prognosis regardless of relief of obstruction. We feel that our fatalities in this disease in recent years have been almost always a result of the lung infection. It is likely that pneumonia is at least 50 per cent more common in nondiphtheritic infections of the air passages than in diphtheria. Naturally, the prognosis in diphtheria cases is greatly improved over these other types because of the specific action of antitoxin. As a rule, the prognosis depends more than anything else upon the age of the patient. All of our patients were ten years old or under. Most of the serious cases were three years or under. The anatomy of the infant's larynx and the lack of cough and use of extrinsic muscles undoubtedly explains this frequency of serious obstructive symptoms. Many patients seen early in their dyspnea and hospitalized with croup tent or oxygen tent and plenty of

fluids may remain mild cases, though destined to become serious if left in their homes.

SUMMARY.

It seems that the recognition of infectious conditions simulating laryngeal diphtheria is of some importance clinically, and from the standpoint of epidemiology. Clinically, if such cases as are described here are treated as diphtheria and antitoxin is relied upon, more appropriate treatment may be delayed or neglected entirely, and the result in some instances may be a fatality which might have been avoided. From the standpoint of epidemiology, the statistics as to the prevalence of laryngeal diphtheria and its mortality rate, the importance of the Shick test, the efficacy of toxin-antitoxin as a preventive and of antitoxin as a curative agent may be affected in a small way at least.

Study of the articles listed in the bibliography has helped the writer immeasurably in arriving at certain conclusions appearing in this paper. Space has not permitted specific reference to individuals or their views concerning this interesting condition. A complete check of the literature on the subject has not been made and undoubtedly many interesting articles have appeared which are not listed here. Enough has been presented, I hope, to emphasize that nondiphtheritic laryngitis and tracheobronchitis are distinct clinical entities of considerable importance both to laryngologist and epidemiologist.

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- 408-15 DAVIDSON BLDG.

XXXIV.

SINUS DISEASE WITH BLOODSTREAM INFECTION.

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The subject of focal infection, particularly in the sinuses, is one which has received much consideration during the past two decades. Its status at this time seems uncertain in the general medical mind as well as in the minds of many otolaryngologists. Like all things, the pendulum for several years swung to the irrational extreme of radicalism in accusation of sinuses and injudicious surgery, and having had time to contemplate the effects thereof, the medical mind has acquired a skepticism which has carried the pendulum well back to the other extreme. Likewise at this time we are so engrossed in the fascinating study of biochemical research and the hope that it will offer a way out of the sinus dilemma, that we are well nigh forgetting the problem in hand—how best to get the patient well.

Aside from local disturbances, it is generally agreed that a certain symptom-complex on the tracheobronchial system is the direct result of sinus infection. Practically all other infectious conditions have been laid at the door of the sinuses by some, and as emphatically denied by others. It is my belief that somewhere between these extremes the truth lies, and since infection and resistance are relative and inconstant factors, that we will find a better answer to the rôle of sinus infections in general diseases by a more intensive study of the individual case.

I wish to present a short history of four cases of bacteremia which have been studied throughout with meticulous care and which we believe were either secondary to sinus infection or were continued by it. There is no question that temporary bloodstream infections occur frequently in severe upper respiratory diseases, particularly sinus and mastoid infections, but recover promptly. These four cases, however, represent the types in which continued foci occur. The maxillary sinuses are probably the

most frequent offenders, but any or all may be responsible for chronic foci. Illustrations herein do not include the study made of other sinuses than the maxillary, except in the typical allergic case.

Case 1.—Miss S. H., aged 39, teacher, presented herself in December, 1927, with pain in the maxillary region and the left eye, and a history of sharp pains in the cardiac region the night before. This condition followed a severe attack of influenza six weeks before, from which she had not fully recovered. She also stated that she probably had a streptococcic bloodstream infection, because petechiae had appeared on her skin a few days ago similar to those which a sister had had, who died of bacterial endocarditis when 28 years of age.

The family history was as follows: Father died at age 61, brain abscess; mother died at age 67, diabetes mellitus; one sister died at age 28, bacterial endocarditis.

Personal history: Had acute diseases of childhood with good recovery, except that suppurative otitis media complicated scarlet fever at 12 years of age; acute appendicitis in 1918; influenza in 1919. There has been considerable postnasal dropping since the influenza in 1919.

On examining the nose we found the mucous membrane much swollen, with pus under each middle turbinate. The contour of the nasal passages was otherwise normal. The tonsils had been removed but the pharynx appeared red and inflamed. Transillumination and X-ray indicated the maxillary sinuses were filled.

This patient was sent to the hospital where Dr. J. A. MacDonald found the following:

Petechial hemorrhages present around the eyes and on the neck; the chest was negative; there was some enlargement of the spleen and liver. G. I. studies were negative. Heart rapid, 110 to 120; slight systolic blow over the mitral area. Temperature, 100° to 101.5°. Blood picture: red cells 3,400,000; hemoglobin, 46 per cent; white count, 10,300; polys, 63 per cent. Wassermann negative. Blood cultures after 24 hours positive for streptococcus hemolyticus.

On the second day the maxillary sinuses were irrigated through the ostium and found filled with pus. Cultures showed staphylococcus aureus and streptococcus hemolyticus. Maxillary irrigation was done at three-day intervals for two weeks, continuing complete bed rest and general treatment. The temperature remained constant. The general condition did not improve and there was no apparent change in the sinus infection. Free drainage of the sinuses seemed indicated and maxillary windows were made under the inferior turbinates. Improvement was slow but continued from this time on. Temperature had become normal and blood cultures negative after four weeks, but occasional petechiae continued to appear for five or six months. Lipiodol studies of the maxillary sinuses were done twice during this time, with practically negative results. (Figs. 1 and 2.)

This patient was given a total and permanent disability income by her insurance company and this was continued for one and a half years. At



Fig. 1 (Case 1).—Anteroposterior view of right maxillary four months after maxillary windows—lipiodol.



Fig. 2 (Case 1).—Lateral view of right maxillary—lipiodol. Indicates little if any residual infection in the sinus mucosa.

the end of this period the patient was clinically well and asked that her disability insurance be discontinued. She has been teaching school since. Heart valves do not show evidence of damage at this time. (Dr. Geo. Bond, cardiologist, I. U.). There is some question as to whether or not a true bacterial endocarditis existed.

The interesting features of this case are: First, the history of infection in the family; brain abscess, probably of sinus origin, in the father; bacterial endocarditis in a sister. Could this be infection from contact, or is there a familial lack of resistance to certain infections? It is not likely a coincidence. In this case we felt that the infection was transmitted to the bloodstream from the maxillary sinuses, and that after free drainage the sinus mucosa healed without infectious foci remaining.

Case 2.—C. G., a physician, age 48, first seen in June, 1930, complaining of general malaise, lack of endurance, and a rather continuous pain and discomfort in the right maxillary region which had begun with a severe cold five months before. The family and past history were entirely irrelevant. There had been no illness and very few colds in more than twenty years. No allergic history.

Nasal examination: The nasal passages were quite normal in size and contour. The mucosa, however, was decidedly pale, but no congestion or edema, and no discharges were observed. Transillumination revealed a slight clouding of the right maxillary sinus. X-ray showed all sinuses normal except for slight evidence of tissue thickening in the floor of the same sinus. The eyes were negative. The tonsils had been well removed several years before. Irrigation of the right maxillary sinus was done by needle puncture under the inferior turbinate. There was some obstruction to the ostium and the fluid returned with several mucopurulent shreds. A culture taken at that time showed streptococcus, but no differentiation was made. Three other irrigations were done at intervals of four or five days, at the end of which time there had been very little improvement, either general or local. It was then decided to make a large window under the right middle turbinate, after which there seemed to be some improvement.

This patient was not seen again by me until July, 1931—almost one year later—with the following history: The apparent improvement resulting from the maxillary window was temporary; the pain and soreness in the right maxillary and teeth had continued to the present time. The general condition had become progressively worse, exhaustion was marked, and there had been a loss of twenty pounds in weight. The patient had visited two diagnostic clinics within the past month for examination with the following findings: Chest and abdomen, negative; heart muscle, "tired"; blood pressure 90/35; vasomotor system otherwise negative. Red count, 3,400,000; white count, 9,300; polys, 57; Wassermann negative; blood culture after 48 hours positive for streptococcus viridans. Urinalysis: specific gravity, 1016; trace of albumin; no casts; streptococcus viridans was grown from the urine. The prostate gland was small and soft; culture from the urethra after prostatic massage showed streptococcus viridans; this organism also was grown from the stool. Temperature ranged from normal to 100°.

Irrigation of the right maxillary sinus was done at this time and staphylococcus albus and streptococcus viridans were recovered; no frank pus



Fig. 3 (Case 2).—Primary film. Slight thickening at base on right.



Fig. 4 (Case 2).—Anteroposterior—lipiodol. Irregularity at base.



Fig. 5 (Case 2).—Lateral—Ipiodol.
Abscess at base—anterior.



Fig. 6 (Case 2).—Marked fibrosis of deep layer of
mucous membrane. Fibrous occlusion of vessel.

present. Primary X-ray plates showed no changes from the condition of one year ago. Lipiodol studies were negative for the left maxillary, but the right showed moderate thickening in the floor. (Figs. 3, 4, 5, 6.)

A radical maxillary operation was decided upon and on opening the sinus through the canine fossa the mucosa in the upper portion appeared very thin and pale. The floor was much thicker and nodular in appearance. On removal it was very fibrous and contained three or four areas of encapsulated pus. From these small abscesses streptococcus viridans was grown.

Recovery was uneventful, except that the maxillary pain was persistent for three or four weeks, but at the end of six weeks the patient was much improved. Blood cultures were negative after three weeks and have remained so.

An examination was made in December, six months following operation. The patient was feeling perfectly well; had regained normal weight; all clinical and laboratory findings were negative. The histological section taken from the lining of the sinus shows a degenerated atrophic type of mucosa with extensive desquamation. The underlying stroma is a dense cicatricial tissue infiltrated with small lymphocytes, large mononuclears, plasma cells and eosinophiles.

In this case a streptococcus viridans bloodstream infection continued nine months to one year without cardiac involvement. Here an atrophic fibrous type of mucosa was present, containing a considerable number of eosinophiles without any past or present indication of allergy. One interesting feature is observed which was present in all three cases where tissue section was done, i.e., there was marked destruction of surface epithelium. We feel this was not a loss of epithelium due to handling, as in this case particularly there was a tendency to replacement by a cuboidal type of cell.

Case 3.—W. T., aged 21, student, gave a history of hayfever in the mother due to ragweed. He had the usual diseases of childhood with good recovery; no serious illness. The patient began having hayfever when three years old, and most of his summers since had been spent in Wisconsin. During the winter of 1928 he had a severe cold which produced continuous nasal obstruction, loss of weight and strength.

In August, 1928, a diagnosis of sinusitis with nasal polyps was made and a nasal operation advised. A partial ethmoid exenteration with removal of polyps was done. A violent nasal inflammation followed, with profound toxemia and prostration. Partial recovery had taken place in two months, when he was seen by Dr. C. P. Emerson of Indianapolis and a diagnosis of bacterial endocarditis was made. This patient was under the constant observation and treatment of Dr. Emerson and Dr. Pond for one year, during which time there was continuous afternoon temperature of one to two degrees, with an occasional exacerbation. During this time an infected tooth and a tonsil remnant were removed, without appreciable benefit.

In May, 1930, an examination of the upper respiratory tract revealed a pale, slightly edematous nasal mucosa, without obstruction to breathing. There was evidence of a previous surgical attack upon the middle turbinates and ethmoids. Tonsils and adenoids had been removed. The sinuses



Fig. 7 (Case 3).—Primary film. Marked transparency of sinuses. Only perceptible increase in density at base of right maxillary.



Fig. 8 (Case 3).—Right lipiodol anteroposterior. Irregularity at base.



Fig. 9 (Case 3).—Lateral film of right maxillary, Iliodol, showing cystic abscess in anterior floor. Note lack of mucous membrane thickening in remainder of sinus.



Fig. 10 (Case 3).—Lateral—posterior sinuses upright, filled by Proetz's displacement method.



Fig. 11 (Case 3).—Lateral inverted—same as Fig. 10.
Note normal appearance of mucous membranes.



Fig. 12 (Case 3).—Microphoto of mucous membrane—marked edema—many eosinophiles. Typical allergic mucosa containing streptococcic abscesses.

were all particularly transparent to the X-ray and transillumination, but there was a little more density in the right maxillary than the left. Irrigation of the right maxillary was done, without recovering pus, but streptococci and staphylococci were both grown from culture. Lipiodol studies of the sinuses were made which revealed evidence of either a polyp or a cystic abscess in the right. The mucosa in the left maxillary sinus was slightly thickened on the floor. (Figs. 7, 8, 9, 10, 11, 12.)

The postoperative course was uneventful. In three weeks the afternoon temperature had reached normal for the first time in one year. Cardiac improvement was slow but continued during the following six months. This patient is again in college and while he has evidence of damage to his cardiac valves, he has resumed normal activities and is clinically well.

This case represents a definite allergic in every detail—hayfever since three years, pale, edematous mucosa, nasal polyps, etc. The histologic picture also is one of allergy—marked edema of the mucosa and many eosinophiles. Here again the epithelial layer is partially destroyed.

Case 4.—P. H., a school girl, age 10, was admitted to the James Whitcomb Riley Hospital on March 8, 1929, with a diagnosis of chorea and endocarditis. The family history was negative. Personal history: Measles, chickenpox and mumps. For six years this patient had had frequent colds and continued nasal obstruction. Two years ago choreic symptoms appeared and at times were quite marked, particularly on the right side. After the usual general study a diagnosis was made of chorea and subacute bacterial endocarditis, involving particularly the mitral valve, and a marked secondary anemia. X-ray and clinical studies of the chest showed peribronchial disturbance, probably from upper respiratory infection; no evidence of tuberculosis. The abdomen, G. I. tract and kidneys were negative. There was a continuous daily temperature of 99° to 100°. The red blood count was 2,900,000; hemoglobin, 68 per cent; white count, 16,000, with 65 per cent granulocytes. The Wassermann was negative and at this time blood cultures were negative.

Examination of the upper respiratory tract revealed infected tonsils and suppurative bilateral maxillary sinusitis. After one month's rest in bed with both general and local treatment the tonsils and adenoids were removed and both maxillary sinuses were first irrigated, both were found filled with pus. Large nasoastral windows were made. Cultures from the nose and the sinuses were positive for streptococcus viridans.

There was no unusual reaction following this surgery. The patient was kept in the hospital two weeks and returned home. For the following eighteen months this patient was kept under constant observation and treatment by the out-patient pediatric department. There were periods of improvement, always followed by exacerbations, and in September, 1930, eighteen months following the original hospitalization, the patient was re-admitted to the Children's Hospital. At this time there was a loud systolic murmur over the apex of the heart. The afternoon temperature continued at 98° to 101°. Blood cultures were taken, the first two being negative. The third was positive for streptococcus viridans. Further studies of the sinuses were made and primary X-ray and lipiodol visualization of the maxillaries indicated thickening with polyps or abscess formation in the mucosa on each side. (Figs. 13, 14, 15, 16.)

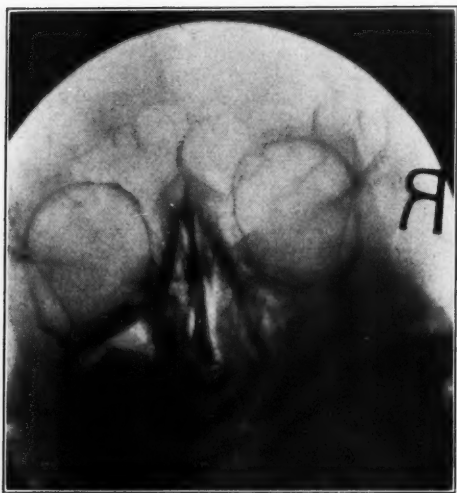


Fig. 13 (Case 4).—Primary anteroposterior film of maxillaries showing cystic abscess in floor, left side.



Fig. 14 (Case 4).—Anteroposterior film, left maxillary—lipiodol.

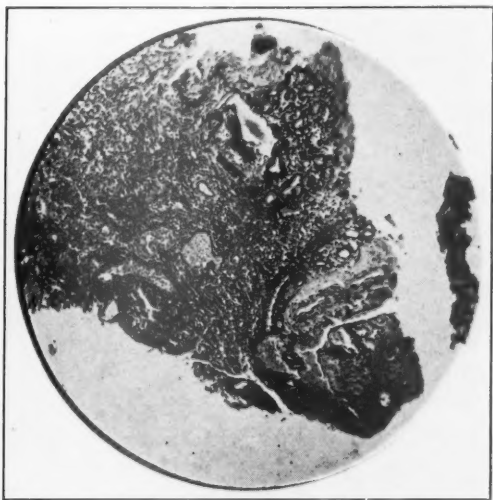


Fig. 15 (Case 4).—Lateral of left maxillary with lipiodol.



Fig. 16 (Case 4).—Microphoto of mucosa removed from left maxillary sinus, showing a more recent inflammatory process. The mucosa contained streptococcic cystic abscesses. Very vascular—much cellular infiltration.

Radical maxillary surgery was advised and done. Both sinuses contained pus. The mucosa was tremendously thickened, was apparently necrotic in areas, and contained many small abscesses. Following the operation a decided reaction occurred, with an exacerbation of the endocarditis, lasting about three weeks. Absolute bed rest was continued for ten weeks after the operation, at which time all evidences of active infection had subsided; temperature was normal; blood cultures were negative; general condition was good. There has been a consistent gain in weight and strength, the heart muscle has compensated for the mitral damage which persisted, and the patient is back in school in good health.

Histologic examination of specimens removed from the sinuses was as follows: Marked infiltration and vascularization of the entire subepithelial mucosa. Necrotic areas appearing throughout the specimen. There is great destruction of the surface epithelium.

Points of interest and similarity in the four cases are:

1. Bloodstream infection, with the same organism present in the sinus; recovery only after sinus surgery.
2. Slight febrile reaction except with acute secondary lesion (endocarditis).
3. Presence of abscesses in varying pathologic types of mucous membrane.
4. Minimum reaction following surgery of the sinuses.

I am convinced that any attempt to curette through a nasotracheal opening, or anything short of so-called radical surgery, would have been ineffectual. I am presenting these cases to emphasize the fact that:

1. The sinuses may be the focus of infection for many general diseases.
2. The streptococcus, essentially a nonpus producing organism, is usually found in a nonsuppurative sinusitis, often with a minimum of pathologic evidence.
3. There is an advantage in visualizing minor filling defects, etc., in a sinus by the use of opaque oils.
4. Infection must always be suspected as a factor in the allergic nose.
5. The necessity of a painstaking study of every case and close correlation of the local with the general symptomatology.

HUME-MANSUR BLDG.

THE PATHOLOGY OF CARCINOMA OF THE LARYNX.*

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About twenty years ago Sir Felix Semon described and illustrated in the *Journal of Laryngology* three cases showing larynx lesions that could hardly be distinguished from one another clinically. Each lesion involved the cord, was a smooth, non-ulcerative, red tumor mass which limited the motion of the cord. Extended study showed one to be tuberculosis, another carcinoma and the third syphilis. At this time he pointed out the difficulties involved in the diagnosis of borderline cases of larynx trouble and subsequent experience of such men as Sir St. Clair Thomson, Herbert Tilley, Watson-Williams, Horne and McKenzie has only tended to confirm the opinion of Semon and his precursors that there is bound to be a large percentage of error in the handling of cases of carcinoma of the larynx. Thomson, Tilley, Watson-Williams, Patrick, Semon, Syme and Horne have all acknowledged having done laryngofissure in supposed carcinoma cases, only to find a tuberculosis of the larynx, and even laryngectomy has frequently been done on tuberculous larynges unsuspectingly.

The difficulties have well been illustrated by Horne, who recently related a case of Howell's, a man of sixty-one, from whose vocal cord a tumor was removed, and after a microscopic diagnosis of carcinoma had been made laryngectomy was refused by the patient. Twelve years later the patient was well, and Horne and Bullock, on re-examining the specimen independently could neither of them find any evidence of carcinoma.

Recent studies on carcinoma are throwing more and more light on the general biologic position of the cancer cell and are helping to correct some of the errors in diagnosis and treatment. We can hardly look upon the cell as being an outcast any longer. Its

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position is more that of an unruly member of society. It runs riot in its own realm but it must have its own environment, its own method.

I wish to show a few of the problems which I have recently faced:

Case 1.—This is a case of keratosis with the epidermis heaping itself up in regular masses such as one finds in an ordinary wart. There is no wild embryonic cell growth in this structure; the mitotic figures are few; the cells are normal in shape and size and regular in formation. Clinically the growth presented itself on the left cord posteriorly to the vocal process, showed but little evidence of inflammatory process and never interfered with the motion of the cord.

Case 2.—This patient, sixty years of age, came to me after two years' hoarseness and a twenty-year cough, exhibiting an infiltrating growth on the left cord. The cord was double normal thickness, smooth, oval, dark red in color, with no limitation in motion. One month later there had developed a large growth on the left cord with a marked limitation in the motion. This growth was removed together with nearly all the cord, and under the microscope proved to be a carcinoma. Two months later there had been a regeneration of a normal cord, and all signs of carcinoma had disappeared save a small swelling in the anterior third of the opposite side. This has not increased in size to date, ten months after the operation.

Case 3.—This patient, fifty-seven years of age, complained of huskiness for one month before my examination. Inspection showed an infiltration of the left cord with limitation of motion and a tendency for the new growth to form papillary excrescences on the surface of the cord. The wall of the larynx was involved. After excision of a portion for biopsy, the rest of the growth was subjected to fulguration. After two sittings in a period of two months there was an entire disappearance of the new growth and the cord appeared to have regenerated itself, with nearly normal function. Later there has been a reappearance of this growth with limitation of motion and a hemilaryngectomy is planned.

Case 4.—This patient, aged sixty, had had hoarseness for one month. Examination showed a right vocal cord twice its normal thickness, red, with small elevations which could be picked off the surface easily with a double curette. There was marked limitation of motion. The microscopic diagnosis was papillary carcinoma. With two operations the surface of the cord was cleaned of all but about three small papillæ. The cord in a month returned to nearly normal whiteness and function was perfect. Six months after the operation patient's voice is clear, the right cord free of growth but slightly larger than the left.

Case 5.—After three years' hoarseness, the patient, aged fifty-eight, on examination, showed both sides of the larynx involved in a general inflammatory process consisting of an irregular, ulcerative growth infiltrating both cords and walls. There was unlimited motion and a diagnosis of lues was made on inspection. The Wassermann and history were negative for lues and a biopsy showed a squamous cell carcinoma. The pa-

tient has been on mixed treatment for nearly a year with a gain of eighteen pounds, and improvement in his general condition. The larynx shows a less angry appearance.

Case 6.—A patient aged fifty-five years. Hoarseness for one and one-half years. Wassermann negative; no history of lues. Inspection shows the cords free of growth but the upper part of the larynx and epiglottis involved in an ulcerative infiltration which from the biopsy proves to be a squamous cell carcinoma. As the patient refused laryngectomy, fulguration was tried. One month after the fulguration the lesion seemed quiescent.

Case 7.—This patient, forty years of age, came complaining of a hoarseness of one year's duration. The right cord was limited in motion, showed a growth in the anterior third of the cord, which was removed. There was a negative Wassermann. Biopsy report carcinoma. Six months later the cord was slightly red, motion good, voice clear.

Case 8.—In March, 1930, patient, sixty-five years of age, came to me from Dr. Poole of Honolulu. After a prolonged antiluetic treatment, a biopsy was done on a laryngeal growth which proved to be carcinoma. The walls of the larynx were fixed firmly in a markedly infiltrating process which clinically appeared to be carcinoma. A laryngectomy was advised but the patient went to Boston, where three specimens were taken from the larynx and diagnosed as nonmalignant. The patient, after treatment for lues, returned to Honolulu unimproved and died within three months. An autopsy showed a carcinoma of the larynx and the slides show the reason for the mistaken diagnosis by biopsy, the lesion being in the deeper tissues with a surface epithelium intact.

Case 9.—Patient aged twenty-two. The voice in this case had never been entirely clear but for the last four years had become very much worse. The larynx showed normal cord movements, the left cord was obliterated by a papilliform growth which, on removal, was diagnosed as papillary carcinoma. The growths were stripped off the cord and in one month's time the cord was free, white, slightly more narrow than its companion and the voice much improved. It is possible to have carcinoma in a young boy but, of course, not common. The movement of the cords is not evidence against early carcinoma. A diagnosis of papilloma would be logical if it were not for the microscopic appearance. Time alone will tell the tale.

Case 10.—Patient fifty years of age. For one year pain in the left side of the throat. On August 3, 1931, a hard mass the size of a thumb nail was removed from the esophageal surface of the larynx. This, on section, proved to be carcinomatous. At operation it appeared as though the whole growth had been removed and a fulguration of the base was done. Subsequently, the clinical history has been satisfactory, the patient gaining in weight and swallowing has become easy, without pain. Here time also will decide, but six months following the operation all is quiescent.

Case 11.—Patient aged fifty. A most interesting case of carcinoma of the upper part of the esophagus and larynx of the most malignant type of adenocarcinoma. The primary lesion was excised to a certain extent

and a deep fulguration done on the remaining portion, checking its growth for a year and then there appeared an entirely different type of malignant growth in the testes, a teratoma, which evidently was not metastatic, but another primary tumor.

Case 12.—A seventy year old man came to me with a well developed cancer of the larynx. The growth involved both cords, was not inflammatory in appearance but looked more like a pachydermia. A biopsy showed a squamous cell carcinoma. Operation was not advised as it was found that the patient had been under treatment for this larynx condition for a period of twelve years. He lived comfortably for ten years following my examination.

We have our data. What conclusions are we to draw from them? Are these cases malignant? What is cancer? On what diagnosis is one justified in interfering radically?

Cancer undoubtedly appears in families but it is certainly pretty well established that it is not transmitted. It would seem that human cells are divided into two distinct groups: (1) Those cells which lead a normal life throughout their existence, the chromosomes dividing according to rule, the protoplasm deporting itself normally towards its neighbors. No irritation can divert them from this normal path. They travel, take in their sustenance, arrange themselves in groupings and die according to certain narrow, accepted, gentlemanly rules. They may be cut into, tramped upon, burned with acid and insulted in the most inhuman manner and they take no offense but build again, in their docile way, a new structure which is a replica of the original. Secondly, the other cell is the direct opposite; it comes into the world hunting for a chance to take offense. At a moment's notice, it resents bitterly any interference and wanders off by itself, seeking to create a new world for itself, built on its own selfish plan.

The first class of cells grows up to manhood and ever acts manly. The second class of cells is always childish, returning to its embryonal habits at a moment's notice. Families of the first class of cells will never be subjected to carcinoma. Families of the second class are ever on the brink.

Malignancy consists in a state of cell growth which is a menace to the life of the patient. Microscopically, the picture may be that of embryonal cells but clinically it may be far different. How far we are to go in the interpretation of these differences marks the value to humanity of clinical experience. To say that every

papillomatous growth that shows carcinomatous changes should be the indication for a laryngectomy would be subjecting many a young person to a silent life who might be given years of efficient activity, even though eventually he might succumb to that very tendency of the cell to embryonal recrudescence.

To take the stand, on the other hand, as many do, that every carcinoma that is removed, leaving a normal larynx, is misdiagnosed, is unscientific, unreasonable and unnecessary, as the type of cell and its action cannot be quibbled with; the history of many a case subsequent to operation has too tragically negated any such thought.

The patient in case 9, for instance, has come out with a normally clean larynx after twenty-two years of history suspicious of papilloma. Yet five pathologists have passed on the slides, and all separately insist that the growth can be nothing but carcinoma. I was called into the case to do a laryngectomy.

Many a case of papillary carcinoma has been removed, the case remaining free for years, and then has developed a growth in the laryngofissure wound or in the cervical glands, the interior of the larynx remaining free. It is not necessary to look upon these cases as transplanted cells; they may be new primary lesions.

There is no doubt that carcinomata of the same type may show marked variation in their malignancy in different people and also in the same individual at different places or times.

Patient 11 at biopsy was given three months to live, so malignant did the lesion look under the microscope, yet he is still alive one year after the biopsy, even though he evidently belongs to the embryonal cell type as evidenced by two primary carcinomata of separate types in different parts of the body. If one is not to take this factor into consideration there will be many an unnecessary tragedy.

Nos. 2, 3 and 4 in the series are cases which seemingly have come out with normal larynges, and although it is too early to draw conclusions, still the evidence is in their favor and is at least a good gamble.

The malignancy in case 12 must have been very much like that of many skin cancers, for it lasted over a period of twenty years

or more without producing any great inconvenience to the patient. What determines the rapidity of growth, the intensity of the malignancy, is unknown but is a very important factor in the handling of the case.

Case 8 illustrates the fallacy of depending entirely on the microscopic picture for the clinical treatment of the patient. Clinically this case was carcinoma. He had had months of efficient anti-tuberculous treatment without effect, and there was no evidence of his ever having had tuberculosis. The local picture was that of an infiltrating growth which had limited the motion of the larynx and had produced extensions in the glands of the neck, yet three superficial biopsies showed no malignancy microscopically, and only a deep section of the larynx after death revealed the true nature of the affection. In this case the clinical picture was paramount and the microscope could well have been disregarded.

If one is guided more or less by these vague general principles in diagnosis of the individual case the better method of attack will, it seems to me, be apparent far more than if one is swayed by the textbook diagnoses; at the same time it is necessary to be thoroughly conversant with the well established findings, namely:

1. The position of the growth in the anterior and middle third of the cord by preference.
2. The appearance as a waxy, pale bluish pink solid mass of infiltrative tissue.
3. The limitation of function. This is a late sign and does not necessarily accompany carcinoma.
4. Invasion of the surrounding or neighboring tissues.
5. The X-ray picture of the larynx: this I only mention to call attention to the valuable work done along this line.
6. Local symptoms such as pain, cough, tickling and tightness, which latter may precede the hoarseness by many weeks.
7. Constitutional symptoms such as loss of weight and anemia, anorexia.
8. Lastly, the brilliant new urine test of Haffner-Beveermann. This test has not as yet been published, but bids fair to act as the Wassermann test in syphilis. It is dependent on the production

of an unidentified indol by active tissue proliferation, is present in cancer in 93 per cent of all cases out of 2,000 tested, and even disappears after the cancer has been removed. It is interesting that in case 4 of my series, one of the earliest cases I have seen, there was a faintly positive Haffner reaction which disappeared after the growth had been removed from the cord. Case 3, also an early one, gave a positive Haffner reaction. Dr. Haffner states that he has been able to follow the clinical course of the cases in a large number examined simply by the intensity of the color reaction. If this proves to be what it evidently purports, it will be one of the greatest boons to the medical profession of our day.

490 POST STREET.

XXXVI.

THE IMMEDIATE POSTOPERATIVE TECHNIC INCIDENT TO A CALDWELL-LUC OPERATION.*

W. P. WHERRY, M. D.,

OMAHA.

It would seem unwise and unnecessary to detail the many reasons for, and the purpose of, the Caldwell-Luc operation in its entirety. Suffice it to say that I have in mind only certain phases of the immediate period in which a suitable technic may be a determining factor in the end result. I refer primarily to the practice of packing the operated field with gauze, and secondly to the method used for encouraging the regeneration of a healthy functioning mucosa.

I believe immunologists accept without reservation the theory of increased resistance of tissues when subjected over an extended period to insult, either chemical or bacterial. Fenton recently made the significant statement that in our insistence upon purely infective phenomena, we have inclined too much toward consideration of the germ and how to kill it; perhaps too little toward study of defensive mechanism. "Roughly speaking," continues Fenton, "it is now accepted that vascular endothelium is the primary factor in supplying the so-called histocytes, which are most important in phagocytosis, in the removal of debris and in the formation of granulation tissues. Not only from the vessel walls and by filtration from the blood stream, but also from among the fixed cells of ordinary connective tissue come these cells which so effectively combat inflammation."

If this be true, it is reasonable to suppose that in the type of hyperplastic membrane usually removed from antrum during a Caldwell-Luc operation there is already present a developed defense mechanism, and there should follow in the reparative process a prompt outflow of true macrophagic over simple poly-

*Presented before the Eastern Section of the American Laryngological, Rhinological and Otological Society, New York, January 9, 1932.

morphonuclear cells. Moreover, if the hypothesis be true, if only in part, even then surgical measures that encourage this preponderance of macrophagic cells, histocytes, if you please, are to be thought of.

Obviously this thought, in its consummation, not only presupposes the maintenance of at least the vascular layer of the periosteum during the surgical removal of the diseased mucous membrane, but also imperatively determines, and I use the word advisedly, the correct elimination of all hyperplastic mucosa.

Knowlton and McGregor, working in Mosher's laboratory upon the maxillary sinus mucosa of dogs, were able to show the incidence of fibroblastic changes upon the operated surface, and proved conclusively the presence of subsequent columnar ciliated epithelium in the newly formed mucosa. This work and the conclusions logically deducted merits serious reflections, since further observation has noted a similar type of repair in the human.

A clinical observation, supported in part histologically, warrants the further assumption that where a new ciliated membrane is developed in the maxillary sinus, an increased resistance to bacterial invasion over the original mucosa is to be expected. As a striking illustration, may I cite a patient from my own practice—a woman, who nine years ago was operated upon by the Caldwell-Luc method—at that time the remaining sinuses were insufficiently drained intranasally. Recently when re-operated upon by an external technic, all the sinuses on the side exposed were found actively involved, grade IV pathology, with the exception of the operated maxillary. The maxillary mucosa grossly was of a normal appearance, two sections were removed, and each contained normal goblet ciliated epithelial cells. This regeneration had not only taken place in the presence of, but had resisted invasion, from the adjacent infection for nine years.

It is axiomatic that epiblastic cells will not regenerate from mesoblastic tissue, yet the admirable work so far reported by the Mosher-Fenton coterie of investigators establishes the opinion that a healthy, firm basement structure can invite a similar regeneration and spread of that epithelial surface most desired, namely, cilia.

From a histobiologic reasoning, it would seem advisable, following a Caldwell-Luc operation, to encourage the rapid outflow of fibroblastic serum, to minimize its disturbance, and to avoid early trauma to this delicate coagulum, since it is a pathologic principle that only where surfaces are injured or in the presence of abnormal changes, is it possible for bacterial massing or colonization. If this reasoning be true, then tight gauze packing following a Caldwell-Luc operation is a contrawise procedure.

In this connection, Proetz makes the significant statement that packing the nose or its adjacent structures at any time interferes hopelessly with ciliary streams and lays the surface open to stagnation and infection. The packing of sinuses (postoperative) also interferes and delays repair, since after the operative trauma the immunity of the individual is his only defense.

May I quote L. W. Dean, who in a discussion stated that if we have cleaned out the diseased mucosa thoroughly, and have done our work properly, we are through with the patient—packing is unnecessary. I cannot help but feel Dean had in mind as much the expectant repair as the possibility of postoperative hemorrhage.

Since practically all of our Caldwell-Luc procedures are done under local anesthesia, there is quite a likelihood of the inferior turbinate reacting to the anesthetic, to the degree that air currents are lessened during that immediate period, I have found it of decided advantage to insert a small rubber tube from the nares, through the antra nasal opening, into the sinus, not for drainage purposes, but as previously stated, to better maintain ventilating currents. This tube is removed in twenty-four hours and the operated sinus filled with oil after the suggestion of Sluder.

In recent years the initial section in the canine fossæ has been left unsutured, as suggested by the late Ross Hall Skillern. In 268 private cases I have found this method most satisfactory. In no instance has a fistula resulted, and the average hospitalization period of the patient has been reduced from five to three days. Furthermore, the immediate reaction of the patient has been changed to that desirable state where very little swelling of the face is noticed and very little headache experienced. The use of postoperative sedatives is usually unnecessary when the

maxillary sinus alone has been attacked. Incidentally a low and wide section seemingly is the most desirable.

Several years ago, Dr. Sluder recommended a $\frac{1}{2}$ per cent carbolic acid solution, thoroughly mixed in liquid albolene, for use in all infections of the respiratory mucous membrane. This formula, followed daily or more frequently, in the problem under discussion, in my practice has proven most satisfactory and makes the reparative period of short duration, particularly when the maxillary sinus alone is involved. Aqueous solutions are but occasionally used, and then only where an excessive accumulation of debris makes necessary thorough cleansing. When aqueous solutions are used the copious flooding of the field with Sluder's oil before and after washing will offset the possible hypotonic change in the mucosa, thus lessening the likelihood of an acid sequence.

Subsequent observation of patients operated upon as described consists very largely in the control of adjacent pathology, a precaution usually insufficiently handled.

I fully realize the existence of two distinct groups of thinkers in our present school of otolaryngology. The first group recognizes only the fact that stratified epithelial surfaces are generated after operations in and around the nose and its appendages. The second and more recent group claims the possibility and probability of normal ciliated epithelium, reforming in these same regions, providing a correct technic is used in the surgical procedure. This second group is perhaps best represented by Dr. Mosher and his coworkers, especially Drs. Knowlton and McGregor; by Fenton and Larsell; Proetz and Anderson Hilding. This latter group, although leaving some gaps scientifically uncovered in their hypothesis, yet present enough proof of facts that clinical procedures as such should recognize.

Aside from the histologic premise in maxillary sinus repair, avitaminosis can be a menacing factor just as it is in the creation of morbid changes. The ease with which accessory sinus infection is created in the absence of vitamin A is significant and prompts the realization that a careful understanding of the food and vitamin status in a sinus patient is desirable. Recently I have been intensely interested in observing the letters passing between a group of twenty-five otolaryngologists, under the guidance of

Jarvis, who are studiously investigating the question of "Diet and Sinus Infection." Particularly have I been interested in the post-operative observations. Just the place this newer approach will have in our surgical armamentarium is, of course, at present indefinite.

My only premise perhaps in presenting this paper has been incident to a fixed conclusion, created from an extensive observation of various operators, that it is indeed easy to become stagnated in therapeutic and surgical pathways quite far removed from the fast changing and ever unfolding truths in the biologic, histologic and biochemical knowledge of tissues.

1500 MEDICAL ARTS BLDG.

DISCUSSION—DR. H. P. MOSHER, BOSTON.

Dr. Wherry has done us the favor to make us stop and think in connection with our operative technic in the radical antrum operation. It is true that this is the most satisfactory of all the sinus operations. He has pointed out, however, that we have learned of late certain new biologic facts about mucous membrane, and he asks in his paper the very important question—Does our operative technic aid or hinder these biologic processes? The great practical point is that postoperative packing of the antrum hinders the normal reparative process. Many, if not most operators in my vicinity use postoperative packing for twenty-four hours or not at all. I have been accustomed to use it for twenty-four hours in order to keep the antrum from filling up with blood clot, such a clot having the habit of becoming septic and messing things up generally.

All the points made by Dr. Wherry will bear careful consideration. He has mentioned Fenton and Larsell, the work on vitamins by Shurly and the preservation of normal air currents, and in this connection quoting Proetz.

Dr. Wherry has referred to the regeneration or the reformation of antral mucous membrane after radical removal as far as this is humanly possible. All histologists will tell you that it is the natural thing for it to occur. Nature wills that it should. Does it reform in a useful state? One cannot establish himself in the antrum with a biochemical laboratory. All we can do is to say that

if normal looking mucous membrane is reformed, it probably functions normally. The reformed mucous membrane must, of course, come from rests left in or from the edge of the opening made into the nose. I believe that the success of obtaining normally formed mucous membrane depends upon doing away with all infection adjacent to the antrum. The nearer we are successful in this the more nearly the formed mucous membrane will approach the normal. Of course, the new covering in places will show fibrosis, the amount depending on the remaining post-operative infection.

If ciliated epithelium is reformed, if the cilia are alive, if glands are reformed in sufficient numbers, I believe we have a normally functioning mucous membrane. I can show you that these vital constituents do reform.

And now first about cilia: In the cadaver I have found them living eleven hours after the conscious death of the patient. In tissue cultures they have remained active three days.

I have found living cilia in regenerated epithelium of the antrum eight months after a radical antrum operation. The reformed cilia were removed from the body six hours after death and continued their independent life three hours more or nine hours in all.

The slides show, besides normal ciliated mucous membrane, the reformation of glands. It has been proved in the dog that glands begin to appear in the reformed mucous membrane at the fifth month. The presence of glands in this case is the first definite time recorded (eight months) of their appearance in human mucous membrane.

XXXVII.

SINUS THROMBOSIS.

ERNEST M. SEYDELL, M. D.,

WICHITA, KANSAS.

Sinus thrombosis is one of the most interesting and, quite often, one of the most complex conditions in otology. There are, of course, the so-called textbook cases, but more often each case presents some variation which makes the diagnosis and treatment of this condition a difficult matter. In this paper, the author will devote considerable space to presenting some of these variations; as, in his opinion, they are of the utmost importance in arriving at a diagnosis and in determining the method of treatment of this condition.

Hoopis, in 1826, was the first to point out the relationship between suppurative mastoiditis and sinus thrombosis. There were quite a number of contributions to the literature following this, but due to the lack of success in treating this condition with conservative methods interest soon waned.

Fifty-four years later, Zufal (1880) read a paper in which he advocated opening the lateral sinus and ligating the internal jugular vein to prevent the spread of infection. In 1884 he carried out this operation. In 1886 Horsley, independent of Zufal, advocated a similar method of treatment. The operation was popularized by Ballace and Arbuthnot Lane in 1889. Since this time contributions relating to sinus thrombosis have remained in the foreground of otologic literature. The subsequent history of the development of this subject cannot be stressed in this paper, though it is interesting to note that the perfection of the operative technic preceded the study of its pathology.

Anatomy.—The sinuses of the dura mater, sixteen in number, are an intercommunicating system of fibrous tubes or canals. These canals are situated between the two layers of the dura—mainly on the inner surface of the cranium. They are lined with a layer of endothelial cells continuous with the lining of the veins.

They gather the venous blood from the brain and its covering as well as a portion of that which comes from the bony skull and also from the veins of the internal ear and the ophthalmic veins. The walls of the sinuses contain no muscle fibers and have no valves except those at the orifices of some of the veins—i. e., at the beginning of the superior longitudinal sinus one finds a valve-like spur projecting into the sinus.

The superior longitudinal sinus extends backward from the foramen cecum to the torcular. It is located in the upper border of the falx cerebri. It usually ends in the right lateral sinus, but may end in the left or in both.

The lateral sinus is divided into a horizontal and a sigmoid portion. The anatomic landmark which separates the sinus into its two divisions is the point where the horizontal portion bends sharply downward and forward. This point is termed the knee. The horizontal portion of the sinus is located in its entirety between the layers of the tentorium cerebelli. The sigmoid portion is only partially so situated. The tributaries of the lateral sinus are:

1. Superior petrosal, which empties into the sigmoid sinus at the base of the petrous portion of the temporal bone near its posterior end, at a point where the horizontal part of the sinus bends to form the sigmoid portion.

2. Mastoid emissary vein, which joins the lateral sinus at a point slightly below the opening of the superior petrosal sinus and emerges through the mastoid foramen. On the external surface this is found just behind the posterior limit of the mastoid process.

3. The anterior and posterior condylar veins, which empty into the sigmoid sinus at the junction between the sigmoid sinus and the bulb.

4. Inferior cerebellar and cerebral veins.

5. Petrosquamous sinus, which is frequently absent, but when present runs along the petrosquamous suture and empties into the lateral sinus.

6. Inferior petrosal sinus, which joins the sigmoid sinus where the latter rests upon the jugular process of the occipital bone. The junction of the two forms the beginning of the internal jugu-

lar vein. Both the superior and inferior petrosal sinuses communicate with the cavernous sinus.

7. The inferior longitudinal sinus is situated in the free margin of the falx cerebelli. It is continued backward and usually empties into the left lateral sinus.

8. The occipital sinus, which begins at the foramen magnum, where it communicates with the posterior spinal veins and terminates in the torcular.

9. The torcular, which is located on the internal occipital protuberance, is formed by the junction of the superior longitudinal, the straight, both lateral, and the occipital sinuses.

The cavernous sinuses—two in number—which are located on either side of the sella turcica.

Surgical Topography of the Lateral Sinus.—A line drawn from the superior level of the external bony meatus to the external occipital protuberance gives a fairly accurate position of the horizontal portion of the lateral sinus from its origin to the knee. A second line drawn from the junction of the petrous, squamous and mastoid portions of the temporal bone to the mastoid tip will outline the sigmoid position. The squamo-mastoid suture, when visible, is the best landmark of the position of the sigmoid sinus. Variations are found in the location of the sinuses in different individuals and also in their location on the two sides of the cranium. Trautman¹ and Whiting² found that the sinus is situated farther forward than usual in individuals in whom the posterior meatal wall slants markedly towards the interior. The right lateral sinus, which is usually larger than the left, usually lies deeper in the mastoid bone, and consequently comes into closer contact with the mastoid cells. It usually lies farther forward in brachycephalic skulls and, also, as Wittmaack³ has shown, in those where faulty pneumatization of the mastoid process exists. In these cases the mastoid process is small or undeveloped.

In addition to the variations in the position of the sinuses, there are numerous variations in their structure: there may be an entire absence of one lateral sinus—usually the left. The horizontal part of the lateral sinus may be absent, the sigmoid portion being a continuation of the superior petrosal. There may be a formation

of two horizontal portions. Even two sigmoid sinuses may rarely be present on the same side.

The internal jugular vein is a direct continuation of the lateral sinus and takes origin in the posterior part of the jugular foramen. The dilated portion of the vein is known as the bulb. The vein courses down the side of the neck, lying to the outer side of the internal and common carotid arteries and unites with the subclavian vein at the root of the neck to form the innominate. At its origin it lies behind the internal carotid artery. It then emerges from behind the artery and lies on the outer side of it on the same plane. The hypoglossal and glossopharyngeal nerves pass between the vein and the artery. The vagus nerve lies between and behind them. The spinal accessory nerve passes usually in front of, but occasionally behind, the vein. The left vein is the smaller.

Externally the course of the internal jugular vein may be mapped out approximately by the anterior border of the sternomastoid muscle. The vein usually lies just a little behind its anterior border.

Etiology and General Discussion.—Sinus thrombosis is by far the most common of the intracranial complications following mastoiditis. Statistics show that it occurs most frequently in men, but vary as to whether sinus thrombosis is associated more frequently with acute or with chronic ear suppuration. The acute exacerbations of chronic mastoiditis play a very important rôle in the production of intracranial complications.

Acute osteomyelitis in children is very frequently complicated by sinus thrombosis.

Bacteriologically the streptococcus is the cause of the majority of these cases (60 per cent). The streptococcus mucosus is especially virulent and is characterized by late exacerbations with fatal outcome. In chronic cases the anerobes or facultative anerobes may be the causative organisms. In the majority of cases sinus thrombosis is caused by an infection resulting from one organism.

Hayman's⁴ statistics show that in 90 per cent of his cases only one organism was found when the blood culture was made from blood removed from the involved sinus. When the culture was made from smears taken from the thrombi a pure culture resulted in only 75 per cent of them.

Other factors which may determine whether an ordinary otitis media may terminate in an involvement of the lateral sinus and which are impossible to evaluate in any given case are:

1. The virulence of the infective organism.
2. The number of organisms present.
3. The general and local resistance of the patient.
4. The anatomic characteristics of the mastoid—i. e., the type of pneumatization, facilities for drainage, etc.

Fieant's⁵ statistics show that in about 79 per cent of the cases the sigmoid sinus is the one to become involved. A thrombosis of the bulb occurs in about 12½ per cent, the petrosals are involved less frequently and the cavernous least of all. The dural veins, the mastoid emissary vein and, in children, the petrosquamous sinus may also become thrombosed. The bulb usually becomes involved in acute infections, while the sigmoid is affected more frequently in chronic inflammation of the mastoid cells.

It must be remembered that not all cases of sinus thrombosis arise directly from the mastoid cells. The location of the bulb exposes it to direct infection from the middle ear, as its floor may be very thin or a dehiscence may be present. The bulb may also become infected from the labyrinth, through the internal auditory vein and the inferior petrosal sinus, as well as by way of the carotid plexus. In these cases there is no surgical mastoiditis present. The inferior petrosal sinus drains the veins from the tympanic cavity, the aqueduct, cochlea and the internal ear. The cavernous sinus may be involved directly by an extension of the infection from the tip of the petrous portion of the temporal bone, or indirectly, because of thrombosis of the veins of the carotid plexus. An involvement of the sinuses may also be caused by a labyrinthitis, especially if paralabyrinthian cells exist, and also from the saccus lymphaticus.

Trauma is also an etiologic factor in the production of sinus thrombosis. It may result from instrumental injury or from the piercing of the sinus by a bone fragment; the latter is more likely to cause sinus thrombosis than intentional puncture or incision, due to the fact that the field has usually been made as aseptic as possible under the latter conditions. Also the edges of the wound

are smooth and do not require any great amount of pressure to produce hemostasis.

Any type of trauma to the sinus walls may produce a sinus thrombosis, in the presence of a bacteremia. Grunert and Zeroni,⁶ Hansberg⁷ and Bondy⁸ have reported cases of sinus thrombosis which followed uncovering of the sinus without apparent injury to its walls.

Pathogenesis: A generalized infection following a suppurative process in the middle ear and mastoid is so often associated with sinus thrombophlebitis that the terms otogenous pyemia and sinus thrombosis are frequently regarded as synonymous. This is incorrect, as it is possible to have a generalized otogenous infection without sinus thrombosis.

Otogenous sinusphlebitis, as stated before, is the most common cause of a generalized otogenous infection. In the great majority of these cases involvement of the sinus is caused by a direct extension of the infection in the mastoid process. In these cases the bone may not show any macroscopic changes but may be found softened and partially necrotic. At times only one or two perisinus cells may show involvement, with little infection in the remainder of the mastoid. In all of these cases there are usually some changes in the sinus wall. This variety of thrombosis has resulted from extravenous extension.

We may also have a thrombosis by intravenous extension. This means an extension through a tributary vein. Here a thrombus forms in a smaller vein and gradually extends into a larger one until finally the extension reaches a sinus. A peripheral thrombus is formed and, if conditions are favorable, the entire lumen of the sinus may become blocked. In these cases the outer sinus wall may appear normal.

Deutsch, quoted by Klestadt,⁹ stated that in a series of cases observed by him, 35 per cent of the fatal acute cases showed no sinus wall changes. Nineteen per cent of the acute cases which recovered likewise showed no pathology, whereas in all of his chronic cases some changes were visible.

I will now take up those pathologic conditions other than sinusphlebitis or thrombosis which may produce a generalized otoge-

nous infection. It has been shown by Brieger,¹⁰ Manasse,¹¹ Haymann¹² and Witmaack¹³ that bacteria may penetrate the veins of the middle ear and thus get directly into the general circulation. The infection may also enter the general circulation through the smaller veins of the mastoid (Korner's osteophlebitis) and also through the mastoid emissary vein, the veins of the internal ear, the saccus endolymphaticus and the carotid plexus.

Pathology: We will suppose that a mastoid infection has extended to the outer sinus wall and that a perisinus abscess exists. What effect will the pus have on the sinus wall? Haymann¹⁴ has thoroughly investigated this field by experimenting on anthropoid apes. It may also be stated that his experiments have been confirmed by clinical observations which in a great measure bear out the fact that similar results may be expected in man.

Haymann found that if he uncovered the lateral sinus and painted its surface with virulent bacteria, no involvement of the sinus occurred. The application of bacteria plus a superficial injury to the sinus wall, also produced negative results. If, however, a tampon saturated with bacteria was placed against the sinus wall and allowed to remain there, infection of the sinus invariably resulted. He also found it impossible to produce a thrombosis by applying pressure on the sinus, but pressure, plus bacteria, always produced infection. Even when he applied pressure over the sinus and introduced bacteria into the femoral vein, infection occurred. From this we may form the following postulate:

The presence of pus, plus the pressure of a perisinus abscess with its granulation tissue, may very easily produce a sinus thrombosis.

There are two theories relative to the formation of thrombi:

1. Talkes¹⁵ and others hold that it is not necessary for the bacteria to penetrate to or through the intima. The chemico-toxic action of germs present in the wall of the sinus may produce the clot.

2. Leutert¹⁶ and others hold that inflammatory changes in the intima are necessary and that germs produce toxins which lower the bactericidal properties of the blood, making thrombus formation easier and that all thrombi are infected from the beginning.

Haymann has shown by his experiments that either or both methods may produce a thrombus and that thrombi may be sterile at first and later become infected. The formation of thrombi is a protective measure.

Haymann, Caldera and Fienzi¹⁷ have shown that bacteria may penetrate the sinus wall without producing a thrombus. In many of these cases an examination of the wall of the sinus under a high magnification showed an irregularity of the endothelium at the point of entrance of the bacteria. Ordinarily, however, more marked changes take place in the intima and these play a very important rôle. Haymann found that marked changes may occur in the intima without the production of a thrombus, but in these cases the endothelium remains intact. Therefore, in his opinion, a lesion of the intima is necessary for the production of a thrombus.

At first we find a small accumulation on the sinus wall which soon develops into a mural thrombus. The current of the blood stream is slower along the walls of the sinus, a condition which aids in the development of the thrombus. The thrombus usually begins on the outer wall but, under certain circumstances, may arise from the inner wall. A mural thrombus may remain as such, or, by the accumulation of fibrin, white and red blood corpuscles and platelets may form an obturating thrombus. A parietal thrombus may or may not be infected, and in either case may or may not produce emboli. There is always a tendency towards organization of thrombi and this may take place in one portion of a thrombus while in another portion purulent degeneration may be found. A parietal thrombus may, of course, cause a systemic infection, but, according to Haymann, due to its early organization, it is rarely the cause of a long drawn out sepsis. An obliterating thrombus is usually laid down in layers. Here organization and suppurative destruction takes place at the same time.

A thrombus may develop either in a central or in a peripheral direction. The thrombus may even extend to the opposite side, or it may extend downward into the subclavian vein.

A thrombus may develop within a few days (Alexander), or, on the other hand, in chronic suppurations of the mastoid bone.

i. e., cholesteatoma, a long time may intervene between the involvement of the outer sinus wall and the beginning of symptoms of sepsis.

Thrombi may be sterile. In fact, the appearance of a thrombus does not indicate whether it is infected. The ends of the thrombus are more or less pointed, redder in color and are usually less infected than the center of the thrombus.

The outer wall of the sinus may become eroded and produce a fistula. The thrombus may even erode the mastoid bone and appear as a subperiosteal abscess, as in the case reported by the author. Hemorrhages from the sinuses are rare, but fatal cases have been reported in mastoiditis complicating scarlet fever and tuberculosis.

Both experimental and histologic examinations of clinical cases have shown that spontaneous recovery is possible. In these cases the sinus either becomes obliterated or recannulated.

The healing process following a sinus operation is similar to the nonoperative cases. Granulation tissue fills that portion of the sinus which has not been removed and organization gradually takes place.

SYMPTOMS AND FINDINGS.

Otogenous sinus thrombosis may present an almost purely local condition, being practically symptomless with perhaps the exception of an increase in temperature. The accidental finding of a thrombosed sinus during a mastoid operation is not an exceedingly rare occurrence. However, as a usual thing, the course of this otitic complication is anything but symptomless and guides us towards a correct diagnosis.

In discussing the symptoms and findings, I will divide them into those which point towards a systemic infection and those which allow us to conclude that the sinus itself is involved. We may, by following the symptoms and course presented, divide the cases of otitic generalized infection into several groups, pyemic, septic, the mixed or septicopyemic, and those which present symptoms of a mild chronic sepsis. Rather frequently fever is the only symptom present in an infection of the lateral sinus, and it is therefore important to cover this phase of the subject rather

thoroughly. The pyemic type is characterized by a pyemic fever. The temperature curve presents steep elevations and depressions which may range from 96 degrees to 106 degrees. The elevations of temperature may occur several times in a twenty-four hour period. Again, the sudden elevation may be followed by one or more days of slightly elevated, normal or subnormal temperatures. These elevations are usually followed by a rapid drop to normal or below.

The septic form is much more infrequent. In these cases the temperature remains high. The pulse is fast and of poor quality and remains so during the remissions and during narcosis. Delirium is frequent.

Both the pure pyemic and septic forms are found much less frequently than the mixed or septicopyemic. In passing, it might be stated that the reason for this is self-evident. In an otitic generalized infection we usually have numerous foci of infection which may pour their toxins—bacteria or emboli—into the blood, causing metastases, a condition which likewise influences the clinical picture.

In the septicopyemic cases the fever may be continual, strongly remittent or intermittent. On the other hand, the patient may have only a few mild elevations of temperature.

Some cases resemble a mild chronic sepsis with a temperature ranging not over 99.6 degrees. A number of cases with positive blood cultures and metastases have been reported with these temperature findings. There are numerous local conditions which may cause a lowered temperature, i. e., a fistula leading from the infected sinus externally—my case. Barth and Brieger¹⁸ reported cases of sinus thrombosis, with cerebral and cerebellar abscesses which, they state, caused a decreased temperature.

Chills associated with a pyemic temperature in the presence of an ear infection should automatically lead one to think of sinus thrombosis, but chills may not be present.

Blau¹⁹ gathered from the literature 100 cases of sinus thrombosis, some of which had metastases, even in the lung and joints, but did not present chills. Takatabake²⁰ carefully studied fifty-one cases of sinus thrombosis. In these, chills occurred in only six cases. In many of the cases where chills fail to occur, profuse

sweats may be present. Chills are much less frequent in children than in adults.

The pulse usually increases and decreases with the temperature. It is usually a bad prognostic indication if the pulse remains fast when the temperature has dropped. An abnormally slow pulse indicates increased intracranial pressure or vagus stimulation due to peribulbar inflammation.

BLOOD.

Blood cultures: In generalized otitic infections blood cultures have assumed a position of importance. The work of Libman,²¹ Leutert²² and Brueger²³ has given the otologist a valuable adjunct in the diagnosis of otitic sepsis. However, the limitations of blood cultures must be thoroughly understood in order to prevent errors in the interpretation of the findings. Careful bacteriologic technic must be employed to get good results. A blood culture is indicated in any case that presents a septic temperature either before or after operation. It is best to take the culture at the height of the temperature, because a negative culture will often be obtained if taken after the temperature has dropped. When chills occur, the culture should be taken at the termination of a chill, as at that time the blood is flooded with organisms.

Findings: A small number of colonies may be regarded as significant if an expert has taken the culture, unless staphylococci are found. When these organisms are found, one must be skeptical—it is always advisable to inoculate several plates. The findings on these plates should not vary materially. It must be remembered that it is possible to have an extensive sinus thrombosis without being able to demonstrate any bacteria in the blood. The ends of the thrombus in these cases may not be infected. When this occurs, one would have a sinus thrombosis with a negative blood culture. One might also have a negative blood culture due to the destruction of the bacteria in the blood. Experiments have shown that in cases of sinus thrombosis more bacteria are found in the blood taken from the lateral sinus than when the blood was removed from the arm.

Libman had negative blood cultures in seventeen of his twenty-six cases of sinus thrombosis.

Again the culture may be positive without a sinus thrombosis being present. In these cases the bacteria enter the circulation directly from the veins of the middle ear and mastoid. In this latter type, positive blood cultures and metastases may occur earlier than where a coalescent mastoiditis has involved the sinus by continuity of infection. In a series of forty-four cases with systemic infection due to hemorrhagic mastoiditis, Kopetsky²⁴ had twenty-seven negative cultures. When he found a thrombosis in the small mastoid veins which extended to but not beyond the vessels in the bony intracellular walls, a positive culture was found in each case. When sinus thrombosis followed a hemorrhagic mastoiditis a positive culture was present in ten of fifteen cases.

The streptococcus, as stated before, is the organism most often found. Kopetsky holds that in the majority of cases it is a hemolytic streptococcus. I have reported several cases where the so-called hemorrhagic mastoiditis or Korner's osteophlebitis existed where this was not true. In one case we recovered a staphylococcus aureus hemolyticus. One must never depend upon a negative blood culture. A positive blood culture in the presence of a suppurative ear condition, unless some other focus of infection can be found, should make one very suspicious of the presence of a sinus thrombosis or phlebitis.

STUDY OF THE BLOOD.

White cell count: The total white cell count and percentage of neutrophils has long been accepted as a guide to the severity of the infection and to the reaction of the patient, but has less value in determining the presence of a generalized otogenous infection.

Arneth (1904) pointed out that during severe infections neutrophils with immature nuclei appear in the blood stream and that these young cell forms disappear during convalescence. Arneth's classification of the white blood cells is so complex as to make it impracticable for clinical use. Schilling has simplified Arneth's classification so that a differential cell count may be made without a great loss of time. In making the count the number of young forms are placed on the left side of the counting page and the number of mature forms on the right.

This procedure is of much greater value in determining the presence of a severe systemic infection than the total white cell count and the percentage of neutrophils. Mullen²⁵ has recently made a valuable contribution to the literature on this subject.

I think the percentage of the polymorphonuclears in the white count is of value, especially if the percentage of polymorphonuclears should increase or remain the same following an operation on the mastoid.

Red Cells and Hemoglobin.—A study of repeated red blood cell and hemoglobin examinations is of great value, especially where we are dealing with the streptococcus hemolyticus. When this organism enters the blood stream there will be a continual decrease in the hemoglobin percentage as long as this invasion continues.

These findings also provide an indication in reference to the necessity of giving a blood transfusion.

PYEMIC METASTASES.

An otitic thrombophlebitis may produce an otitic pyemia, bacteremia or toxemia. It is interesting to note how emboli are disseminated from the thrombotic sinuses. These emboli may be composed solely of bacteria or blood platelets plus bacteria or particles of thrombi.

As a rule, the bacterial emboli are able to pass through the lung into the circulation, but large particles of thrombi are arrested there. Emboli large enough to cause instant death are rare.

In a large number of operated cases of sinus thrombosis which were taken from the literature it was found that metastases developed in 40 per cent. In another series in which sinus thrombosis resulted fatally postmortem examination showed that 50 per cent had developed metastases.

Although statistics vary, it would seem that more metastases develop in cases of chronic suppuration of the mastoid. The metastases may develop from emboli which enter the blood stream from the middle ear, mastoid or sinuses, or secondarily from the focus of infection which developed from a primary embolus.

There is no question that many emboli which are disseminated throughout the system do not produce metastases. We must

realize that each chill or rise of temperature indicates that a quantity of infectious material or toxins has entered the general circulation. In the majority of these blood invasions the bactericidal and antitoxic properties of the blood prevent the formation of metastases and destroy their infectious properties.

From the localization of the metastases we may classify the following forms of otitic pyemia:

1. Cranial with intracranial metastases. Suppurative foci may develop in the eye, nose, sinuses, pharynx, tonsils, etc. The pia and arachnoid may become involved and brain abscesses have been reported.

2. Thoracic with metastases in the pleura, lung and heart—especially the endocardium (Kummel). Lung abscesses are found more frequently in the chronic cases. These may as elsewhere be single or multiple. They usually occur near the periphery and in the lower lobes. In a series of cases which came to postmortem 88 per cent had lung abscesses.

3. Abdominal, producing peritonitis—abscess of the bladder, etc.

4. Peripheral with metastases in the skin, bursa, muscles and joints. The smaller emboli lodge most often in the above mentioned tissues, especially the bacteria type.

There is no regularity relative to the time, number and virulence of the emboli. They have been known to occur from six to eight weeks after the lesion in the sinus and mastoid has been healed.

In this case there is usually only a slight systemic reaction. Bacteria may be found in the blood for months after the infection in the sinus is apparently well (Alexander²⁶).

GENERAL CONSIDERATIONS.

In the beginning of the disease, between the occurrence of the chills and sweats, the patient looks well, but in the later stages he presents the appearance of a very sick person.

Delirium, somnolence, incontinence of the bladder, etc., are usually manifestations of a severe infection.

The spinal fluid in uncomplicated cases is usually normal, although at times there is an increase in the spinal fluid pressure. Alexander and Guttich²⁷ state that in children it is possible to

have an increase in globulin and a small number of lymphocytes. Even leucocytes may be found.

With increased intracranial pressure one may also find changes in the eyegrounds, such as optic neuritis and choked disc. These findings appear in both the complicated and uncomplicated forms of sinus thrombosis.

In a series of 162 cases of sinus thrombosis, Blau²⁸ found eyeground changes in 69 per cent, but statistics gathered by different authors vary considerably in reference to these findings. Disc changes may be unilateral or bilateral; if unilateral, they are usually found on the involved side but may occur on the contralateral side. When bilateral, they are usually more pronounced on the affected side.

Crowe and Beck have shown that compression of the jugular vein produces an edema of the disk. If one sinus is occluded by a thrombus, pressure on the opposite jugular will produce an edema of the disc on the compressed side. This procedure has only a relative value in diagnosis.

LOCAL SYMPTOMS.

Cerebral: It is a well known fact that fatal cases of sinus thrombosis are often associated with meningitis and brain abscess. These cases usually show unmistakable cerebral symptoms.

It is also true that uncomplicated cases of sinus thrombosis, especially early in their course, may frequently have cerebral manifestations. These symptoms are usually transient and generalized.

Psychic depression, most often temporary in character, may be present. Cerebration is usually normal.

Headache is frequently lateralized to the side involved, but may be frontal or occipital. A unilateral headache is especially important if it continues or arises after a mastoid operation.

EXTERNAL MANIFESTATIONS.

Griesinger's sign is a localized painful swelling at the posterior edge of the mastoid and is supposed to be caused by an extension of the thrombus from the lateral sinus to the mastoid emissary vein. This sign is very frequently absent in sinus thrombosis and

may be present when sinus thrombosis is absent, i. e., Bezold mastoid.

A more important sign, but again an unreliable one, is the presence of pain and swelling in the region of the jugular vein. One may be able to palpate both the swollen cervical glands and also a thickened and hard strand extending down the side of the neck which may easily be interpreted as being a thrombotic jugular vein. These findings may be present or absent where a thrombus exists, or may be present when no thrombus exists. When a thrombosis of the lateral sinus extends into the bulb and jugular vein, and when a periphlebitis develops in the jugular foramen it is possible that the ninth, tenth and eleventh nerves may become involved in the inflammatory process, causing hoarseness, dyspnea, slow pulse, difficulty in swallowing, and spasms in the distribution of the spinal accessory.

DIAGNOSIS.

On account of the variability and inconsistency of the signs and symptoms arising in the course of an otogenous general infection, considerable training in otology, a keen knowledge of general medicine, experience and profound judgment are frequently necessary to establish a diagnosis.

If, in the course of an acute or chronic ear suppuration, which has not presented any severe subjective symptoms, the patient suddenly develops a septic temperature accompanied with rigors, and if in addition he suffers with a severe unilateral headache on the affected side one must become very suspicious that the patient has a surgical mastoiditis with an intracranial complication. A positive blood culture and eyeground changes, especially, when the greater disc change is on the affected side, materially help in establishing the diagnosis.

A complete history of the case should be taken. One must always keep in mind the possibility of a sinus thrombosis when treating either an acute or chronic otitis media. The temperature must be carefully observed and the patient's attendants instructed to watch for rigors or chilly sensations and profuse sweats. Unilateral headaches which either persist or arise after a mastoid operation should be regarded with suspicion. The same may be

said of the leucocyte count. A white count that remains high or increases after a mastoid operation or during the course of an acute or chronic otitis media usually signifies that all is not well. The presence of metastatic foci must not be overlooked.

No case should be allowed to come to operation until a thorough physical examination has been made to exclude the possibility of other foci which might be the cause of the patient's septic condition. Unfortunately, many cases of generalized infection do not present a definite symptomatology. The picture may be hazy and indefinite. These are the cases which test one's diagnostic acumen.

Another difficult problem is presented in those cases where a bilateral otitis media exists in the presence of septic symptoms.

Prior to any mastoid operative interference, we must rely upon those tests which demonstrate a lack of venous circulation or increased intracranial pressure. As already stated, the Crowe test is not reliable. The presence of optic neuritis and choked disc may be helpful. The side upon which there is the greatest amount of eyeground change usually points to the side upon which the sinus is thrombosed. Dr. George Tobey has presented to us a method which is of assistance in establishing the diagnosis of sinus thrombosis and is a modification of the Queckenstedt test. A spinal needle connected with a spinal manometer is inserted and the amount of spinal fluid pressure noted. Pressure is now applied on one jugular vein—if made on the side which is completely thrombosed, no great change will occur in the pressure of the spinal fluid, but when the normal side is compressed a very definite rise of fluid will occur.

It must be remembered that in order to have a positive reaction an obturating thrombus must be present. Therefore, this test has no value in case of mural thrombi. The test is more likely to prove successful if made soon after the circulation in the sinus has been cut off by the thrombus, as later compensation may take place. The location extension and anatomic variations may also make the findings unreliable.

In reply to inquiries sent to a number of leading otologists in different sections of the country with reference to their experience with this test, I find that some men never have used the test, others deem it unreliable, but the majority state that it is valuable,

yet, on account of the reasons just set forth, not absolutely reliable. In my survey of the literature on this subject, I found that in twenty-five operated cases, seventeen were properly localized; in six cases the thrombus was not found on the side toward which the test pointed, and in two cases it was found on the opposite side.

DIFFERENTIAL DIAGNOSIS.

By a careful examination one should be able to exclude meningitis, except perhaps in those cases where sinus thrombosis is complicated with a serous meningitis.

Where otitis media arises during another disease or is complicated by it, one finds it sometimes difficult to make a differential diagnosis.

Among such diseases are furunculosis of the external auditory canal. Erysipelas may appear either before or after an operation on the mastoid. It may arise on any part of the body. In some cases temperature and chills may be present for a week prior to the appearance of the eruption. Acute anginas may present a septic temperature, chills and a bacteremia. The acute infectious diseases, influenza, granular fever—especially in children; endocarditis, typhoid, tuberculosis and enteritis in children, pyelitis, undulant fever, appendicitis and cystitis may all resemble sinus thrombosis symptomatically. Malaria with its chills presents another diagnostic difficulty.

In acute articular rheumatism one must differentiate rheumatic involvements from metastases. Finally, pneumonia, especially bronchial pneumonia in children, cannot at times be differentiated from sinus thrombosis.

Therapy of Generalized Infection of Otitic Origin, Including Sinus Thrombosis.—The chief objective in the treatment of this condition is the elimination of the causative focus.

Since spontaneous cures occur only at rare intervals, the treatment is primarily surgical. In so far as the secondary suppurative foci—the metastases—are accessible, they also require surgical intervention.

It is absolutely essential that every effort be made to support the general health and resistance of the patient by whatever means may be required.

OPERATIVE TREATMENT.

As I have previously pointed out, it is impossible to differentiate clinically between sepsis produced by a sinus thrombosis and the same condition produced by a thrombosis of the veins of the middle ear and mastoid. This being true, no general rules can be laid down relative to the surgical treatment of otitic sepsis prior to an exploratory operation on the mastoid.

There should be a complete exenteration of the mastoid. If any cells are found beyond the confines of the process they should also be removed. Fistulae leading towards the sinus must be carefully explored. The sinus plate should always be removed in the presence of septic symptoms, and this procedure must be carried out so that the sinus is exposed throughout the entire sigmoid area. In removing the bone over the sinus it is best to use either a drill or a flat chisel. The bone should be removed in small shavings, the chisel being held flat against the surface of the mastoid.

It is not advisable to make a funnel shaped exposure of the sinus. After an opening has been made, it can be rapidly and safely enlarged by using either a curette or rongeur—usually both. One must take great care neither to injure the sinus wall by breaking off too large a piece of the sinus plate nor to force spiculae through it. If the sinus is at all adherent, it should be separated from the overlying bone by an elevator. It is advisable first to remove the bone from the torcular end of the sinus and then to work towards the bulb, as the sinus wall is thinner and more adherent in this region and might tear, thus delaying the completion of the operation.

Only in certain cases will sinus wall changes allow one to draw definite conclusions as to its contents, i. e., where a defect, gangrene or a total collapse of the wall is found. Where the wall is discolored, has a hard, sausage-like feeling, and is hard to compress, one can, of course, feel reasonably sure that a thrombosis exists. Whether the thrombus is sterile or septic cannot be determined by observation.

ACUTE HEMORRHAGIC MASTOIDITIS.

In dealing with an acute case (Kopetsky's hemorrhagic type), especially in children, if the patient's general condition is favora-

ble, even though septic temperature, rigors and metastases have been present, it is good surgery to await the outcome of the mastoid operation before opening the sinus or ligating the jugular. If the hemoglobin constantly decreases, if the patient's general condition grows worse—if chills, sweats, fever and metastases continue—in other words, if the patient's general condition is not greatly improved following the mastoid operation, further surgical interference is indicated. If the patient's general condition is good, the sinus may first be explored, the thrombus removed and an attempt made to obtain free bleeding from both ends of the sinus. If free bleeding cannot be established, the jugular should be ligated. If the patient's condition is bad, the jugular may be ligated before exploring the sinus.

EXPLORATION OF THE SINUS.

Sinus puncture should be carried out with a large caliber needle attached to a syringe. The needle should not have too sharp a point or too long a bevel. Sinus puncture findings are valuable only when no blood can be withdrawn from the sinus and when one is certain that the point of the needle is within the lumen of the vessel. If fluid blood is withdrawn from one area of the sinus it is advisable to repeat the puncture at one or more points, i. e., the knee and near the bulb. In doubtful cases the blood which has been withdrawn should be cultured.

ACUTE CONFLUENT MASTOIDITIS.

Even though the mastoid operation reveals a confluent mastoiditis with destruction of the sinus plate and the presence of a perisinus abscess, with changes in the sinus wall, unless the latter is destroyed, is gangrenous or collapsed, the decision whether one should defer further treatment and await the results of the mastoid exenteration or should explore the sinus depends on the clinical picture presented.

If the septic condition has been of short duration and the patient's general condition is good, or if metastases have occurred but are limited to the extremities, I await the outcome of the mastoid operation. If the patient's condition is not favorable, I explore the sinus. If a thrombus is found, these questions arise:

1. Should the jugular be ligated before removing the thrombus or after removing it?

2. Is it best to remove the thrombus without ligating the jugular either before or after?

I decide these questions after taking into consideration the patient's clinical picture and the condition of the thrombus. I would ligate all cases where no free return of blood could be obtained from the bulb.

CHRONIC MASTOIDITIS.

In chronic mastoiditis, especially when a cholesteatoma is found, otitic sepsis nearly always is due to a thrombosis of the sinus. In these cases I explore the sinus at the time of the mastoid operation.

Surgical Procedure in Reference to the Sinus.—A small pencil of indoforn gauze is introduced under the bone overlying each end of the exposed sinus and the sinus is opened. The outer sinus wall is incised. If no thrombus is found, the gauze plug which compresses the sinus at its torcular end is removed, but if free bleeding ensues the plug is quickly replaced. If no bleeding occurs the sinus is uncovered posteriorly to the torcular and the search for the thrombus continued. The plug towards the bulbar portion of the sinus is now removed and the same procedure is repeated. If a thrombus is found, it is removed with a suitable forceps, curette or by suction. The question as to whether it is always necessary to establish free bleeding from the torcular end of the sinus has not been settled. On several occasions, where the thrombus has extended far back towards or beyond the torcular, I have allowed a portion of it to remain without any bad after-effects. If free bleeding occurs, the sinus is again plugged and the mastoid wound is packed but not closed.

If no bleeding or very little bleeding follows the removal of the lower plug, the jugular is ligated and a rubber suction tube is inserted towards the bulb and an attempt made to remove the thrombus by suction. It must be remembered that where no thrombus is found in the sigmoid portion of the sinus, one may be present in the bulb. A free return of blood following the

removal of the lower plug does not disprove this fact, as unless the inferior petrosal is also thrombosed bleeding will occur.

Method of Procedure Where a Double Mastoiditis Is Associated With Sepsis and a Positive Blood Culture.—It is sometimes a very difficult matter to determine which mastoid is the cause of the blood stream infection. One must resort to a number of expedients, none of which is absolutely satisfactory.

The pathologic changes found at the time of operation are a great help. We may expect to find the thrombus on the side on which we find the older lesion and the most destruction. The appearance of the sinus wall and the presence of a unilateral headache are helpful in lateralizing the affected side. Dr. Barnhill has noticed that there is more venous oozing on the side on which the thrombus exists.

The Crowe test may be utilized, but has much less value than the Ayers Tobey test. If one is still in doubt, the one sinus may be opened and if the thrombus is not found one may explore the opposite sinus after an interval of several days. In one case reported in the literature both sinuses were obliterated and one jugular tied. The patient recovered. So far as I know, only one case has lived following a double jugular ligation. This was a case operated on by Dr. McNally of Montreal.

Lilly, Bondy and others have noticed that septic temperature, chills, etc., have disappeared after removing the gauze packing which has been in contact with the sinus following a mastoid operation. It is a good rule never to allow gauze to come in direct contact with the sinus or dura.

The question when it is best to ligate the jugular vein has been in dispute since ligation was advocated as a method of treatment, and there is as yet no agreement between otologic surgeons on this point. Some ligate before opening the mastoid, others after the mastoid operation has been completed but before opening the sinus; still others open the sinus but ligate before disturbing the thrombus; again, others remove the thrombus without ligation.

Those who advocate preliminary ligation insist that this procedure prevents, in a large measure, the occurrence of metastases both during and after the removal of the thrombus. They also hold that there is little or no danger from ligation and that it is

possible to make a clinical diagnosis of sinus thrombosis before operation.

The literature on this subject would tend to show that in many cases metastases do occur subsequent to ligation and in some cases have been caused by ligation, i. e., cavernous sinus thrombosis through the inferior petrosal. Both Heine²⁹ and Haymann³⁰ state that they have not seen any serious consequences result from removing a thrombus from the sinus or bulb when this procedure has been carried out prior to ligation of the jugular.

There are several cases in the literature where, although at operation a complete connective tissue occlusion of the jugular vein was found, metastases had occurred nevertheless. Ligation, therefore, does not prevent the transportation of pus and bacteria from the infected sinus. It only cuts off the main centripetal channel.

There is little danger in ligation of the jugular if the operation is performed by a skilled surgeon. Injury to the vagus nerve and carotid artery is not impossible and postoperative infection is always a possibility.

More dangerous than these are severe reactions resulting from a lack of collateral circulation following the ligation. Linser³¹ examined a large number of skulls and found that 3 per cent of those which he examined had an extremely small jugular foramen on one side. This finding occurred five times more frequently on the left than on the right side. The foramen in these cases was too small to allow the passage of a vein that could establish collateral circulation, and undoubtedly severe reactions and perhaps death might have resulted if ligation had been resorted to in these cases.

There is further danger that ligation will cause an extension of the thrombus. Several cases have been reported where ligation of the jugular was immediately followed by an involvement of the cavernous sinus.

The ligation of the jugular must be followed by opening and obliterating the sigmoid sinus; otherwise, if a mural thrombus is present it will immediately be converted into an obturating thrombus. If an obturating thrombus is present, it may extend, i. e., through the inferior petrosal to the cavernous sinus.

STATISTICS.

Statistics comparing the results obtained by primary ligation with those obtained by surgeons who follow distinct indications for ligation cannot be depended upon.

Alexander,³² who advocates primary ligation, claims a mortality of 22 per cent in 155 cases, whereas Haymann's³³ statistics show that he lost 27 per cent where the thrombus was found and where preliminary ligation was not followed.

We must remember that Alexander's cases include all cases of otitic sepsis, irrespective of whether a thrombus was found at the time of operation or not. His statistics therefore include all of the cases of osteophlebitis in which neither ligation nor opening the sinus is necessary.

Haymann reported 300 cases of otitic sepsis which were treated in his clinic. In the acute cases 33 per cent were ligated and of these 50 per cent lived. In the 67 per cent which were not ligated 95 per cent lived. In his chronic cases 52 per cent were ligated and of these 60 per cent lived. The mortality of those which were not ligated was 28 per cent.

These statistics do not prove that it is better not to ligate, since the cases which required ligation were severe cases and those which had no ligation were mild ones, consequently no comparison can be made.

OPERATION ON THE JUGULAR VEIN.

A sandbag is placed under the neck so that the tissues are put on a stretch. An incision is made along the anterior border of the sternomastoid muscle from a little above the hyoid bone to or near the clavicle. All bleeding points are grasped. The incision is carried through the platysma muscle and the cervical fascia. Superficial veins are ligated and severed between two ligatures. The sternomastoid muscle is dissected away from its surrounding structures by blunt dissection. The anterior belly of the omohyoid is pushed aside or may be cut. The carotid sheath is carefully opened and the jugular vein is freed from the vagus nerve and the carotid artery which is contained with it in the carotid sheath.

The vein should then be carefully examined. The same principles that held true with regard to the lateral sinus also hold true here.

The lower ligature is placed well down in the neck. This should be done as early as possible to prevent disseminating particles of thrombi which may be present in the vein.

The upper ligature is now placed as high up in the neck as can be conveniently reached. I always attempt to ligate above the facial vein. All venous tributaries are ligated and cut between two ligatures.

If I can determine that a thrombus or phlebitis exists, I resect the vein. Otherwise I merely ligate. In case there is a jugular thrombus with no flow of blood from the bulbar end of the sinus and the patient's condition is grave, I suture the upper end of the vein to the wound in the neck. Rubber tissue is pushed upward towards the bulb and the remainder of the wound closed by layers. No attempt is made to irrigate the bulb.

Medical Treatment.—Some authors advocate the use of intravenous injections of mercurochrome, typhoid bacilli, etc. Dr. Ersner advocates the use of Dick's serum in streptococcic mastoiditis with septic symptoms. He reports good results in a small number of cases which he has treated by this method. I have not had any personal experience with these methods of therapy. Transfusions of whole blood are used only when the hemoglobin drops to 55 per cent.

Fluids are given in large quantities. The general medical therapy is symptomatic.

PROGNOSIS.

The general symptoms may continue for some time even after ligations of the jugular and obliteration of the sinus. This is especially true of the fever. The temperature, chills and metastases may continue for several weeks, the patient ultimately recovering. Those patients in whom the fever resolves by lysis usually have a better prognosis than where the temperature drops at once to normal and then rises again. A sudden drop in the temperature following the operation may signify collapse.

When the patient has a positive blood culture prior to the operation and it becomes negative following the same, when the

leucocytosis, and especially the high percentage of polynuclear cells diminish after the operation, when repeated Shilling blood counts reveal a steady turn to the right, one can state that the prognosis is relatively good.

Where metastases have occurred the prognosis is better if these are limited to the extremities.

The mortality statistics vary from 20 per cent (Alexander) to from 40 to 60 per cent by other authors. Death is usually due to the bacterial action on the vital organs.

Terminal infections such as pneumonia and meningitis are frequent.

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XXXVIII.

SINUSITIS IN CHILDREN.*

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PHILADELPHIA.

From earliest infancy paranasal pneumatization is sufficient to make sinusitis a condition to be considered clinically, not only in cases with readily demonstrable infections, but also to be investigated in many cases with obscure symptoms and uncertain etiology. Some anatomic studies made within the past two decades showing the extent and types of pneumatization during the developmental period^{1 2 3 4} undoubtedly exerted a stimulating influence on more accurate observations of the clinical manifestations of infections in these areas. Sinusitis continues to be a most interesting and fascinating field for investigation because the anatomy of the areas shows such variations, the symptomatology is so inconstant and often misleading in diagnosis, and the selection of plans of treatment calls for exercise of the soundest judgment and experience in determining whether a case should be treated by nonsurgical measures alone, or, if surgical measures are also indicated, the type and extent of the necessary operative procedures.

In average cases all of the sinuses have assumed their approximate adult type of outlines by the fourteenth year,⁵ although their ultimate maximum dimensions have not been reached. Thus, as far as the observations in this paper are concerned, we shall arbitrarily consider childhood as terminating at the end of the thirteenth year.

Any condition which interferes with free nasal ventilation and drainage acts as a predisposing factor in sinus infections. Among such causes most frequently encountered are hypertrophic nasal and pharyngeal mucosa resulting from enlarged infected tonsils and adenoids, pale, boggy mucosa associated with allergic condi-

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tions, enlarged or malformed turbinates, septal deviations, ridges or spurs, cleft palate, atresia of nares, traumatic deformities of the nose, transient swellings from trauma, foreign body in nasal passage, and obstructing tumors.

Among general predisposing causes there are endocrine disorders, metabolic disturbances and lowered resistance from unbalanced or deficient diets.

Not infrequently sinus infections develop as complications or as sequelæ to acute colds, tonsillitis, measles, scarlet fever, whooping cough, pneumonia and more rarely diphtheria. Lack of sunshine, unfavorable climatic conditions—especially excessive dampness and sudden changes in temperature—swimming and diving are etiologic factors in other cases.

I doubt whether there is any other location, with the possible exception of the tonsils, in which infection is known to produce such a wide range of symptoms, complications and sequelæ. To enumerate some of the conditions in which we know that sinus infections must be considered when endeavoring to locate the primary underlying cause, the following list is believed to be a practical one for clinical purposes: Acute or chronic pharyngitis with congestion extending downward from the nasopharynx along the posterior faucial pillars, hypertrophy of lymphoid follicles in the posterior pharyngeal wall, submaxillary adenitis, cervical adenitis, frequent colds, recurring epistaxis, otitis media, phlyctenular conjunctivitis, orbital cellulitis, orbital abscess, optic neuritis, persisting cough without demonstrable intrathoracic cause, acute or chronic bronchitis, bronchiectasis, enlarged peribronchial lymph nodes, peribronchial thickening, nontuberculous pulmonary infiltration, anemia, anorexia, malnutrition, asthma, myocarditis, chorea, acute rheumatic fever, arthritis, recurring fever of unknown origin, nephritis, pyelitis, meningitis, cavernous sinus thrombosis and brain abscess.

The diagnosis of sinusitis undoubtedly is made more frequently now than during previous years, but it is probable that the apparent increase in the number of cases is due more to careful diagnosis, both by pediatricists and rhinologists, rather than to an actual increase in the relative frequency of the infection.

In my series of cases, the relative frequency with which the predominating infections have been located in the different sinuses of children is, in descending order, ethmoidal, maxillary, sphenoidal and frontal. Ethmoid infections often occur alone. Maxillary infections are nearly always secondary to ethmoid infections, but may sometimes persist alone after the ethmoiditis has subsided. I have never seen a case of maxillary sinusitis of dental origin in a patient under fourteen years of age. I have never seen a sphenoidal infection in a child in which there was not also posterior ethmoiditis—the ethmoiditis most probably being the primary infection. Frontal sinuses begin their ascent into the vertical portion of the frontal bone in average cases at the end of the second or during the third year. Their infections in childhood are always secondary to anterior ethmoiditis and are treated as ethmoid infections. I have never seen a frontal sinusitis under fourteen years of age in which I felt that any radical operative measures were necessary.

While the majority of sinus infections in children occurs between the fourth and ninth years, definite virulent infections are not infrequently found in infants. In 1923⁶ I reported a case of suppurative maxillary sinusitis in an infant, thirteen days old, in which the bone destruction had been so rapid that spontaneous perforation of the anterior maxillary wall had already occurred. Death resulted on the nineteenth day from pyemia, multiple metastatic abscesses and septic pneumonia. Also another case⁶ which, when six weeks of age, developed an ethmoiditis resulting in death two weeks later from an orbital abscess and meningitis. While most early cases respond to treatment and very seldom show bone involvement, these cases are mentioned again to show how rapidly destruction of surrounding bony tissue may sometimes occur in infants.

In reviewing the literature of the past few years one must be impressed by the increasing stress being placed upon diet and allergic states in relation to sinus infections. The splendid studies by Dean⁷ and his associates on this phase of the subject are especially well known to all of us. The importance of foods containing vitamin A has been shown both by many clinical observations and by laboratory research.⁸ In several laboratories white rats

deprived of vitamin A foods soon showed definite sinus infections. On the other hand, Tilden and Miller, at the Rockefeller Institute, working with monkeys deprived of fat soluble A vitamin, observed that the first symptom due to vitamin A deficiency was loss of weight followed by loss of appetite, and finally by colitis and death, but total absence of sinusitis.

Dr. H. A. Reisman,⁹ in the Archives of Pediatrics, concludes that "Whatever the relationship of vitamins to sinus infections, it must be only an indirect one, probably one of lowered resistance of the cells of the upper air passages to infection. For if it were not so, then our diet treatment for sinusitis, rich in all three vitamins, would be either more specific or at least more successful."

While allergic conditions are dominant etiologic factors in the development of some sinus infections, yet in other cases I believe they may be the result of the infection, the patient being sensitized to proteins in the exudate formed in his own sinuses.

In diagnosis attention must be given to a careful history, including family tendencies. Nasal discharge, thin and watery, mucopurulent or purulent, may or may not be present. The nasal mucosa may be irritated and congested or pale and boggy—especially when there is an associated allergic condition, or in some rare instances the appearance may be practically normal. Polypoid degeneration is much less frequently found than in adults. Supraorbital headache and pain in the distribution of the fifth nerve may occur, but not so frequently as in adults. Transillumination is of some diagnostic value but is not to be considered as reliable as in adults. Well taken and carefully interpreted X-ray films I regard as indispensable in making an accurate and complete diagnosis, and they should be routinely carefully studied by the rhinologist, especially if operative measures are anticipated. Clinical evidence must be compared with the roentgenologist's interpretation.

Bacteriologically the infections are usually of a mixed type, and any of the organisms frequenting the upper respiratory areas may be found. Pneumococci and streptococci usually predominate.

The fact that so many factors may be combined in the etiology of sinusitis makes the elimination and evaluation of the several possible causes often a procedure requiring both experience and patience. Treatment is also much more difficult in children than in adults. Each case, of course, has its own individual requirements and problems, but the following is an outline of the general plan by which I have obtained the best results in treatment:

1. Regulate diet and correct nutritional disturbances so far as is possible. The use of foods normally containing the desired vitamins is preferable to the use of concentrated vitamin preparations in most cases. Recommended diet has liberal amount of milk, cream, butter, eggs, vegetables and fruits, whole wheat cereals in moderate amount. Other carbohydrates usually should be limited. Many cases require co-operation with a good pediatricist.

2. If there is an allergic state an attempt is made to identify the allergen and to eliminate its contact if possible, or else to increase immunity to it. These studies should be made by an experienced allergist.

3. Internal Medication.—In acute cases small doses of atropin sulphate at three to six hour intervals. In older children ephedrin sulphate is sometimes used instead of atropin, dose $1/10$ to $1/5$ grain, at six or twelve hour intervals. Calcium with small doses of parathyroid often is beneficial. If there is evidence of thyroid deficiency, thyroid extract in small doses is given. Cod liver oil is given once or twice daily. In subacute or chronic cases iodide of iron is used. Vaccines—either autogenous or stock—are valuable aids in many cases.

4. Local Treatment.—Mildly astringent oil solutions alternating with argyrol, 10 per cent, are preferred. If ephedrin solutions are used they should be weak, followed in fifteen minutes by argyrol or some other colloidal silver preparation. Ephedrin used liberally for several days sometimes causes irritation or even superficial ulceration of the nasal mucosa. The reaction following the primary constriction of vessels often gives more than the original amount of congestion. This result is not so marked when ephedrin is given internally.

5. Surgical procedures should be conservative. The endeavor is to secure ventilation and drainage with the least possible trauma

and destruction of intranasal structures. If enlarged or infected tonsils and adenoids are present they should be removed. Local and systemic treatment should be continued for several weeks after the operation. Many sinus cases are cleared up by this plan of treatment.

6. If after nonsurgical treatment polypoid tissue persists in the ethmoid area it should be removed, also the anterior portion of the middle turbinate.

7. Many maxillary infections clear up after removal of an enlarged middle turbinate. If additional ventilation and drainage are needed an opening beneath the lower turbinate should be made. Such openings usually close rapidly in children.

8. Orbital abscesses,¹⁰ due to extension from ethmoid infection, most frequently form between the lamina papyracea and its relatively thick layer of fibroperiosteal covering. The accumulating pus causes separation of this covering from the bone, and associated with the surrounding cellulitis and edema causes lateral and anterior displacement of the orbital structures. Drainage of such abscesses through the anterior ethmoid area is most satisfactory. The middle turbinate, the anterior ethmoid cells and a part of the lamina papyracea are removed. In all of my cases there has been an associated suppurative maxillary sinusitis. Thus a naso-antral opening is made beneath the lower turbinate at the same time. A supplemental external incision into the orbit is seldom necessary, but if it is believed that the purulent exudate has extended beyond the fibroperiosteal layer an incision is made along the upper medial orbital wall and a small drain inserted. After any operation on the sinuses continuation of postoperative treatments until the areas are completely healed is important, since synechia form more readily in children than in adults.

In spite of our best efforts by medical, local and surgical measures, I am sure we all have many cases in which the results are not entirely satisfactory. Sometimes the membranes remain engorged or hypertrophic, in others some foci of infection persist, or there is a tendency for infections to recur easily.

Lyman Richards¹¹ recently reported an interesting study of the results in 500 cases of sinusitis treated at the Children's Hospital

in Boston during the past fifteen years. A comparison of the results obtained by surgical and by nonsurgical measures was tabulated, based upon conclusions formed from three methods of approach. First, from a study of the hospital histories and records. Second, from answers to a questionnaire. Third, from an X-ray study of the sinus areas at the present time. His Figure 1 gives the status of medical treatment as contrasted with that of surgical treatment, the latter being a composite figure made up from the various surgical procedures carried out.

FIGURE 1.

RESULTS OF TREATMENT (BY QUESTIONNAIRE).

Type of Treatment	Cured	Improved	Unimproved
Medical.....	44%	17%	39%
Surgical.....	34%	20%	46%

His Figure 2 is an analysis of the end results according to whether patients were treated medically or surgically.

FIGURE 2.

Result	Surgical Treatment (46% of Total)	Medical Treatment (54% of Total)
Cured.....	37%	63%
Improved.....	48%	52%
Unimproved.....	47%	53%

His other analyses and comparisons showed that in acute cases the higher percentage of cures was obtained by surgical treatment, while in chronic cases the higher percentage of cures was obtained by medical treatment. The X-ray reports on the present condition of the sinuses very closely paralleled the symptoms reported by questionnaire.

The number of cases classified as unimproved is most striking and must impress upon us the fact that in addition to local treatments and conservative surgery there is need of more thorough study and more adequate treatment of the associated systemic disturbances in our sinusitis cases if we in the coming years are to show better records in this phase of our work, which is such an important factor in the great problem of child conservation.

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XXXIX.

MASTOIDITIS IN INFANTS ASSOCIATED WITH GASTRO-INTESTINAL SYMPTOMS.*

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LOS ANGELES.

Every physician who has had infants under his care is entirely familiar with the cases involving extreme illness, acute nutritional disturbances, diarrhea, vomiting, dehydration, progressive loss of weight, lethargy and prostration which have gone on to fatal termination in spite of all efforts in routine and dietary treatment. The relative frequency of this type of case and the serious prognosis which accompanies it has inspired a wide search for a causative focus of infection which could be removed and the lives of these infants saved. Our attention has been called, during the past few years, to extremely encouraging reports from different men in this country who have been working on this problem. They have found that a great majority of these infants afflicted with severe gastro-intestinal disturbances as the outstanding symptoms also have accompanying foci of infection in the ears and mastoid antra. Removal of these foci by means of mastoid antrotomies have given remarkable results in many cases showing no response to the usual medical regime of treatment. The striking results reported by Marriott, Lyman, Alden and McMahon of St. Louis, and Dean, Lierle, Jeans and Floyd of Iowa City, have been the inspiration of our investigation of similar cases in the Children's Hospital, Los Angeles. Our report is based on the results of eight cases of severe gastro-intestinal disturbances associated with mastoiditis and in which mastoid antrotomies were performed.

*Thesis submitted to the faculty of Otolaryngology of the Graduate School of Medicine of the University of Pennsylvania in partial fulfillment of the requirements for the degree of Master of Science (Med.) for graduate work in Otolaryngology.

A study based on investigations at the Children's Hospital, Los Angeles.

The evidence gained from survey of the literature establishes the fact of the association of ear and mastoid infections with severe gastro-intestinal disturbances even though there is variation in the opinions of recognized good men as to causal relationship. The high mortality of these cases forces the important problem as to the most efficient procedure in reducing this mortality. Radical methods on those very sick patients can only be justified by results obtained. Only the statistics of the experiences of the men engaged in this work over the country can formulate the final opinion. The work reported to date has aroused considerable interest among the profession and also concern as to over-enthusiasm.

SYMPTOMS.

The symptoms recorded in the cases herewith presented seem to be identical with case reports reviewed from other parts of the country. The disturbance is constitutional with severe gastro-intestinal symptoms outstanding. There may or may not be a definite history of respiratory infection. The onset, usually abrupt, quickly becomes serious and usually requires early supportive treatment to prevent a fatal termination during the treatment of the infection. The symptoms in general consist of a marked and rapid loss of weight, fever, diarrhea, vomiting, dehydration and evident intoxication. Diarrhea in varying degrees was present in all of our cases, its severity directly influencing the degree of dehydration. Administration of fluids only seemed to increase the frequency of diarrhea without influencing the dehydration. Frequent vomiting occurred in all but two of our cases. Temperature was inconstant, ranging from 101 to 104. The infants appeared very ill, the intoxication being characterized by drowsiness or stupor and pallor with a grayish hue. The child is listless and loses all interest in everything, including his feedings. The face is expressionless and as the condition advances reveals extreme exhaustion.

There is no evidence in the child's behavior suggestive of ear-ache. The child does not cry as a rule and there are no symptoms directly suggestive of ear or mastoid involvement. Careful examination of the ears only will reveal the objective findings

indicating ear infection; which consists of drum hyperemia, thickening of drum, bulging of drum, a dull gray drum with loss of reflex, perforated drum with aural discharge or a sagging of the posterior superior canal wall. These findings are inconspicuous in some cases but can be detected if ears or mastoids are involved. All of our cases showed drum hyperemia, two presented dull gray drums and five showed sagging of posterior-superior canal walls. The typical findings of a mastoiditis, with edema over the mastoid cortex, forward position of the auricle and smoothing of the postauricular creases are lacking and hence the expression of "masked mastoiditis," which Floyd has used in reporting his cases.

ANATOMY.

In view of the fact that all of our cases observed were under the age of seventeen months, the majority under one year, it is necessary to consider the anatomy of the infantile middle ear and mastoid in order to better understand their susceptibility to infection and to explain the resultant findings. In the first place, the eustachian tube is short, broad, patulous and more horizontal than in the adult and offers easy entry of an upper respiratory infection into the middle ear. The tympanic cavity, aditus and antrum in the infant are filled with embryonic tissue similar to granulation tissue which is gradually absorbed. According to Lyman, this is not completed until the first to second year. The presence of this granulation, together with the rather redundant mucous membrane so fill the tympanum and the antrum that infections have poor drainage, especially if the antrum is affected. The spaces are small and very little swelling of the mucous membrane of the aditus is required to shut off the antrum,—the infection remaining in the antrum causing constitutional symptoms. This is the reason why suppuration in an infant's mastoid antrum often cannot be adequately drained by the ordinary incision through the tympanic membrane.

The lack of development of the bony portion of the external canal gives an altered position of the drum as compared to the adult. The inner end of the membranous canal is attached directly to the annulus tympanicus. The squamous portion of the temporal bone does not project horizontally outward as in the

adult, and the annulus tympanicus is almost in the same plane as the superior canal wall, which places the drum in a more horizontal position than in the adult. Consequently any bulging in the posterior superior portion of the drum will be more downward than outward. The tympanic annulus is also incomplete in its superior portion and an accumulation of fluid in the mastoid antrum will show as a bulge downward of the superior wall of the auditory canal. Hence, the frequency with which a posterior superior drum and canal wall is noted.

The infantile mastoid is largely diploic and presents only the one cell, the antrum. Consequently the X-ray gives practically no information from this small area and the typical symptoms of mastoiditis found with involvement of cortex cells are not present.

BACTERIOLOGY.

Cultures from these infected antra indicate that the etiological organism may be one of several, the most frequent being staphylococcus aureus, streptococcus hemolyticus and pneumococcus. In the majority of reports reviewed the predominating organism was streptococcus hemolyticus. In their earlier reports, Alden and Marriott regarded the streptococcus hemolyticus as the specific causative organism.

Our cultural results on the other hand revealed staphylococcus aureus as most frequently present, occurring in four cases. Streptococcus hemolyticus was found in one case and pneumococcus in one. In one case the culture revealed no growth. We must conclude from bacteriological observations in these cases that the etiology is not confined to a specific organism. It may be significant that the one case showing streptococcus hemolyticus did not survive, but the gastro-intestinal disturbances in the staphylococcus cases were also extremely severe, one not surviving.

BLOOD FINDINGS.

There was nothing particularly significant in the blood pictures of these cases. White blood counts were only moderately elevated—ranging from 8,000 to 21,000. A higher average is reported by Lierle whose cases showed leukocyte counts of from 10,000 to 40,000. Jeans and Floyd report their counts from

13,000 to 30,000. The red cell counts were not seriously affected, all cases showing over 4,000,000 except one case, which had a count of 2,600,000. Hemoglobin was rather low with a variation of 55 to 80. Wassermann reactions were negative in all cases.

PATHOLOGY.

Pathological findings in this group of infantile mastoiditis cases differ from the typical mastoiditis in their lack of bone necrosis. The usual finding at operation is a rather thick purulent or mucopurulent pus filling the antrum. The underlying mucous membrane appears edematous. A few of the antra appeared to be filled with granulations, which were probably the embryonic tissue not yet absorbed. All of our cases revealed pus in one or both antra at operation. Four cases revealed pus bilateral. Autopsy on the three cases which did not survive all showed pus in the mastoid antra and edematous mucous membrane. No bone necrosis was present. The gastro-intestinal tracts of these infants revealed no definite pathology.

The most extensive and recent work in the pathology of the mastoid in these cases was reported by McMahan in 1928. In addition to noting the presence of the pus and thickened mucosa he found that the microscopic picture presented a thickened, edematous mucosa with a more or less marked infiltration by polymorphonuclear leukocytes, young connective tissue cells and red blood cells. The changes in the bone, consisting of some fragmentation and varying degrees of absorption of the calcium, suggestive of mild necrosis, were so irregular that they could not be considered pathognomonic. A further interesting observation which McMahan noted was that the mortality was much higher in mastoiditis associated with gastro-intestinal symptoms in the cases showing marked mucous membrane edema.

TREATMENT.

The serious prognosis which accompanies the severe gastro-intestinal disturbances which these infants have in addition to their mastoiditis, makes it very necessary that treatment be handled by both the pediatrician and otologist. The infant should first have the advantage of expert dietary management, intra-peritoneal injections of physiologic sodium chloride solution,

transfusion, intravenous dextrose, etc., combined with drum incision and the usual treatment of otitis media. If, after this has been accomplished, there is no satisfactory response in the general condition of the infant or symptoms involved, antrotomy should be performed, provided the otologic findings warrant such procedure. The pediatrician and otologist by working in conjunction with each other will avoid the danger of the otologist being too enthusiastic in operating unnecessarily and also the danger of the pediatrician prolonging his treatment before operation is performed. The latter is frequently the case and as a result the infant comes to operation in a morbid condition.

All of our cases had excellent dietary and routine management under competent pediatricians and were referred for operative work only after having failed to respond to the more conservative treatment. Myringotomies were performed on all but one infant. In most instances the treatment was too prolonged and as a result the infants were in poor condition, having been referred for antrotomy as a last resort.

As has been stated previously, all of our operated cases presented definite otologic findings and in fact six of the infants had purulent drainage from one or both ears, myringotomies having been performed in conjunction with the conservative treatment. Bilateral antrotomies were done on all cases, which proved to be justified by the finding of pus bilaterally in five of the eight cases. Lyman emphasizes the necessity of opening both antrums and says that "In almost every one of the few cases in which operation was performed only on one side, it was necessary to open the opposite antrum later." The most important consideration in the operative procedure is that the very ill infant be subjected to the least possible manipulation in order to avoid all possible shock. Consequently, we have followed the operative method and technique similar to that used by Alden and Lyman. All the operative work was performed under local anesthetic, using one-half per cent of novocain injected subcutaneously and subperiosteally. The usual incision for an infantile mastoid operation is made starting opposite the middle of the external auditory meatus and extending upward about three-fourths of an inch. The periosteum anterior to the incision is then elevated and the bony canal exposed.

The position of the antrum is then located in the triangle between the posterior curve of the auditory canal and imaginary lines extending backward from the top of the canal and vertically from the posterior border of the canal. At this point the bony cortex is gently removed by means of a hand gouge, thus avoiding any concussion. This usually uncaps the antrum and pus can be seen if present. The contents are then gently removed by a curette but no actual curetting of bone is done. A small rubber drain is then placed in the antrum and the wound dressed without suturing. This having been completed, the opposite antrum is opened in the same manner. This simple procedure is completed in a few minutes' time and if properly done has caused no shock to the patient. Our observations have revealed no harm caused by this operative procedure and we feel certain that the operation has not caused the death of any of our infants.

Postoperative care requires the continuation of careful dietary management and supportive measures including saline administered freely and transfusions if necessary. Our experience indicates that repeated transfusions are of infinite benefit both preoperatively and postoperatively.

The end results of our group of eight cases of infantile mastoiditis associated with gastro-intestinal disturbance and dehydration upon which double antrotomies were performed were five recoveries and three deaths. In the cases which survived, the direct response following antrotomy was definite and particularly striking in two infants. The improvement was noted in decline of temperature, cessation of vomiting and diarrhea, gradual increase in weight and the resulting general improvement of the infant. The patients operated on before their condition became too bad responded more promptly. Two of the infants which did not survive did not come to operation until five and three and one-half weeks, respectively, after onset of their symptoms. The success of antrotomy is in relation to the promptness with which it is done. Alden and Lyman call attention to the fact that their mortality has been materially reduced due to the fact that their more recent cases have come to operation earlier. The three infants that died developed complications, two revealing pneumonia and one a lung abscess at autopsy.

Although it is impossible to determine whether or not these infants would have survived without operation, yet, in view of the fact that they came to operation in poor condition and the majority as a last resort, we are of the opinion that the mortality in this group of cases was materially reduced because of antrotomies performed.

CASE HISTORIES.

Case 1.—M. P., age four weeks; female, Mexican. Entered hospital May 19, 1929. History of frequent stools and temperature for four days following a mild upper respiratory infection. No vomiting. Small, poorly nourished dehydrated infant. Right ear drum bulging and red. Left ear drum dull gray. Examination otherwise negative. Weight $5\frac{1}{2}$ pounds. Temperature 100. Laboratory: Urine negative except for trace of albumin. Hemoglobin 75; R. B. C., 4,520,000; W. B. C., 11,400. Wassermann negative. Throat culture negative for K. L. Infant was put on routine treatment including attention to diet and saline administered. Myringotomies performed on both ear drums with purulent discharges. Infant became progressively worse during four days' treatment. Temperature 101. Loss of weight to five pounds. Ears continued to drain moderately. Bilateral antrotomy performed May 25, local anesthesia. Pus found in both antra. Culture: staphylococcus. Marked improvement on first postoperative day. Temperature began to fall and became normal fourth day postoperative. General condition much improved and diarrhea much diminished May 28. Gain in weight by fifth day and weight increase steady to seven pounds at discharge June 16.

Case 2.—D. C., age five months; female, Mexican. Entered hospital July 16, 1928, because of persistent vomiting, diarrhea, anorexia and loss of weight and cold. Infant had cold one week ago and six days ago began to vomit and have diarrhea which has continued severe. Examination revealed poorly nourished underweight child which appeared very ill and lethargic. Nose and throat moderately injected. Right ear drum reddened and dull. Left drum dull. Mucous rales over lower lobes both lungs. Temperature 99. Weight 11 pounds 4 ounces. Laboratory: Urine, moderate albumin; trace acetone; hemoglobin 55; R. B. C. 4,100,000; W. B. C., 9,550; polys 46%. Wassermann negative. Throat culture negative to K. L. Conservative treatment failed to check the vomiting and diarrhea and the infant was progressively losing weight. Ear examination of July 24 showed both drums red but not bulging. Double myringotomy was done and frank pus was recovered from right and seropurulent drainage left. Profuse drainage continued from right ear but no improvement in patient. Double antrotomy on July 27. Pus in both antra. Culture showed streptococcus hemolyticus. July 30 infant taking feedings better and diarrhea diminished but dehydration marked and temperature remained up around 102. Weight decreased even more rapidly postoperatively. Condition rapidly became worse August 1 and infant died August 3. Autopsy showed bilateral mastoiditis and bronchopneumonia.

Case 3.—I. H., age 16 months; female, Japanese. Admitted to hospital October 24, 1929, with history of severe illness for one week. High temperature, severe diarrhea, vomiting and considerable loss of weight. Child appeared very ill, lethargic, listless and dehydrated. Corneal reflexes absent. No light reaction to pupils. Nose and throat negative. Right ear-drum dull, reflex absent. Left ear drum dull gray. Scattered rales over base of lungs. Abdomen retracted and flaccid. Weight 15 pounds 4 ounces. Temperature 106. Laboratory: Urine showed trace of albumin; R. B. C., 5,030,000; W. B. C., 17,188; polys 69%. Wassermann negative. Spinal fluid cell count 5 per cm. Throat culture negative to K. L. Stool culture negative for typhoid. The infant was placed on conservative routine treatment and showed slight improvement for few days, the temperature dropping to 100 and fluctuating between 100 and 102. After two weeks' treatment the infant continued to have diarrhea, was progressively losing weight and was markedly dehydrated. Temperature reached 104 November 11. Ear inspection revealed hyperemia right drum and yellow discoloration postinferior quadrant. Myringotomies were done; bloody mucus recovered from right and yellow pus from left. No appreciable improvement was noted and antrotomies were performed November 14. Pus was found in both antra. Culture, pneumococcus. The infant showed a striking response in improvement following operation as evidenced in diminishing diarrhea, ability to take and retain fluids, increase in weight of one pound by fourth day postoperative. Repeated blood transfusions proved valuable in enhancing recovery. Infant was in excellent condition and weighed 17 pounds 7 ounces at dismissal December 20.

Case 4.—L. H., age four months; female, Mexican. Admitted to hospital June 12, 1929. History of vomiting, diarrhea, loss of weight. Stuporous for few days previous to entering hospital. Examination presented very ill, poorly nourished, markedly dehydrated, lethargic infant. Chest negative. Abdomen flaccid. Nose and throat moderately injected. Right ear drum hyperemic. Left ear drum injected and bulging. Temperature 105. Weight 7 pounds 8 ounces. Laboratory: Urine negative; hemoglobin 82; R. B. C. 4,960,000; W. B. C. 8,500; polys 36%. Wassermann negative. Bilateral myringotomy was done on June 13, pus recovered from both ears. Infant placed on medical treatment. Repeated saline injections administered. Ears drained freely but temperature fluctuated between 100 and 103 and infant continued to lose weight. Diarrhea not influenced. Double antrotomy performed June 20 under local anesthesia; profuse thick pus in both antra. General condition markedly improved within few days after operation. Temperature fell to normal on fourth day. Patient gained eight ounces in weight in first week postoperative. Diarrhea subsided and feedings were being taken well by June 28. At time of dismissal from hospital July 20 infant had gained two pounds. Stools were normal and antral drainage cleared up.

Case 5.—S. R., age three weeks; female, American. Admitted to hospital July 4, 1928, with history of severe vomiting, temperature and loss of weight past week. Examination revealed small, undernourished, dehydrated infant. Examination at this time otherwise negative. Temperature 100. Weight 6 pounds 8 ounces. Laboratory: Urine, trace albumin; hemoglobin 75; R. B. C. 5,120,000; W. B. C. 9,550; polys 53%. Wasser-

mann negative. Infant placed on medical treatment but progressively became worse. Saline injections and blood transfusion gained no improvement and after one week has lost nine ounces in weight and continued vomiting. Inspection of ear drums July 23 showed bulging of posterior-superior canal wall of right ear and hyperemia of left drum. Temperature up to 103. Bilateral antrotomy with finding of pus in right antrum. No drainage from left. Culture from antral drainage reported staphylococcus aureus. Definite improvement in general condition was noted by the third day postoperative and by the fifth day the vomiting had stopped and child was taking feedings well and showed gain in weight. Improvement continued satisfactorily and child was dismissed August 14 in good condition, weighing 7 pounds and 8 ounces.

Case 6.—R. Y., age ten months; male, Mexican. Admitted to hospital August 3, 1929, with history of four days' severe vomiting and diarrhea accompanied by temperature. Examination presented a poorly nourished, dehydrated infant which appeared very ill and stuporous. Eyes were dull and rolled upward. Mouth was dry and fetid. Ear drums injected and bulging. Heart, lungs and abdomen were negative. Temperature 101. Weight 11 pounds 5 ounces. Laboratory findings: Urine negative; hemoglobin 75; R. B. C. 4,450,000; W. B. C. 9,300; polys 48%. Wassermann negative. Throat culture negative to K. L. Saline hypodermoclysis was administered at once and double myringotomy done; pus found in both ears. Slight improvement was noted for the next two days but again became worse as ears stopped draining. Myringotomy repeated August 7. Diarrhea and temperature continued and infant was losing weight and becoming more lethargic. Bilateral antrotomy performed August 9, with finding of pus in both antrums. Culture, staphylococcus aureus. Definite general improvement was noted by August 12. Diarrhea subsided and was only moderate. Infant was taking feedings. Temperature down to 99. Improvement continued progressively and weight was up to 12 pounds 5 ounces on August 23.

Case 7.—R. S., aged 19 weeks; male, American. Admitted to hospital December 31, 1928, with history of persistent vomiting, diarrhea and loss of weight for three weeks. Examination presented fairly well developed child which did not appear extremely ill but was considerably dehydrated. Nose and throat negative. Ear drums mildly injected. Heart, lungs and abdomen negative. No improvement was accomplished after ten days routine medical management. Temperature 100. Weight 12 pounds, 6 ounces. Laboratory: Urine negative; hemoglobin 60; R. B. C. 2,420,000; W. B. C. 7,474; polys 19%. Wassermann negative. Diarrhea persisted and vomiting was frequent. Dehydration was worse in spite of repeated saline hypodermoclysis. Myringotomies were done and pus found in left ear. No drainage from right. Temperature fell to 99 but no appreciable improvement was noted in patient as result of myringotomy. January 14 ear inspection revealed sinking of posterior-superior wall left and hyperemia of right drum. January 15 temperature was 102. Double antrotomy performed under local anesthesia with finding of pus in left antrum and granulation tissue right antrum. Cultures were reported as showing no growth. No improvement was noted following antrotomy. Diarrhea still persisted and the infant refused feedings. Dehydration and

general condition gradually became worse. January 22 the condition of the patient continued poorly and pneumonia changes in both lungs were noted. The pneumonia process progressively extended and the infant died January 25. Autopsy report showed pus in both mastoid antra and double bronchopneumonia.

Case 8.—E. O., age 15 months; male, Mexican. Admitted to hospital July 27, 1929. Onset of illness two weeks previous beginning with diarrhea which partially subsided for few days and then became associated with persistent vomiting, resulting in extreme pallor and dehydration. Examination revealed a very ill, listless, anemic looking dehydrated child. Eyes and nose were negative. Throat showed tonsils and pharynx moderately injected. Right ear drum negative. Left ear drum injected and dull. Heart, lungs and abdomen negative. Temperature 101. Weight 17½ pounds. Laboratory: Urine showed trace of albumin; hemoglobin 78; R. B. C. 4,720,000; W. B. C. 21,200; polys 77%. Wassermann negative. Widal negative. Blood culture no growth. *Bacillus coli* culture from stool. Throat culture negative to K. L. Spinal fluid culture negative. Cell count 10. Mastoid X-ray negative. Child put on routine medical regime and showed some improvement for few days. Diarrhea subsided but weight curve continued down. Ear inspection on August 1 showed injection right drum. Left drum dull gray. Myringotomy done on left with serous discharge. Some improvement was noted in decline of temperature but condition of child not otherwise affected. August 6 condition considerably worse, temperature elevated, vomiting and diarrhea persisted and infant showed one pound loss in weight under treatment. Ears showed serous drainage right and dull gray drum left. Bilateral antrotomy performed August 8 with finding of pus left antrum and pus and granulations right antrum. *Staphylococcus albus* reported from culture. A temporary improvement followed operation evidenced by subsiding of diarrhea and gain of six ounces in weight. Infant became worse again August 15. Had a septic temperature fluctuating between 102 and 104. Examination on this date revealed rales in right lung, and scalp abscess posterior to mastoid wound. Temperature and decline continued with death occurring September 4. Weight held fairly well and was 17 pounds at death. Autopsy findings were bilateral mastoiditis, right lung abscess and epidural abscess.

CONCLUSIONS.

1. Mastoiditis is frequently associated with severe gastro-intestinal disturbance in infants.
2. Mastoiditis may be the causative agent when associated with gastro-intestinal symptoms.
3. Etiology is not specific to one organism but may be due to one of several common organisms.
4. Antrotomy is a justifiable and beneficial procedure in the treatment of these cases.

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XL.

FRACTURE OF THE LARYNX WITH REPORT OF A
CASE.*

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OMAHA.

The following case report is prompted by the scarcity of like reports in the literature and the small amount of material in our textbooks on the subject.

A young man employed by an automobile dealer as a transport driver was delivering a car and ran into bad roads. The car came to a quick stop and the man was thrown suddenly forward, striking his Adam's apple against the steering wheel with considerable force.

He lost consciousness for a brief time and upon regaining consciousness had a severe pain in the neck. This pain was aggravated by talking and swallowing. The area around the Adam's apple became swollen and very tender. He had no difficulty in breathing and did not spit blood at any time.

I first saw him five months after the accident, at which time the thyroid cartilage was prominent with some swelling on the left side, which was very tender on palpation. The thyroid cartilage was freely movable laterally and crepitus was felt on the left side far back. Movement of the cartilage was accompanied by considerable pain.

Pain was experienced on swallowing and during phonation. The speaking voice was about as before the accident. Examination of the interior of the larynx revealed a normal larynx. There was no evidence of a previous injury to the cords, arytenoids or mucous lining of the larynx.

X-ray of the larynx was negative. No fracture was demonstrated radiologically at this time. One radiologist had reported

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a month after the accident a fracture of the larynx, and still another radiologist reported a fracture of the hyoid bone.

Immobilization of the larynx was advised and the patient subjected himself to this treatment September 19, 1931. The larynx was splinted in the following manner: Pieces of tongue blade about two and a half inches long, covered with gauze bandage, were placed perpendicularly along each side of the larynx. The upper ends of the splints were placed just below the mandible, while the lower ends rested on the clavicle. These splints were held in place by adhesive straps covering the larynx and splints, and extending around the neck.

The patient was given nasal feeding through a Lavine tube. A typical menu for the day consisted of: Tomato juice, 8 ounces; oatmeal gruel with sugar and cream, 12 ounces, at 7:30 a. m.; orange and fruit juices, 13 ounces, at 10:30 a. m.; water, 6 ounces; Cream of wheat gruel with sugar and cream, 10 ounces, at 12:30 p. m.; cereal gruel, 18 ounces; malted milk, 12 ounces; water, 6 ounces, at 6:30 p. m.

His daily meal contained from 3000 to 3600 cc. of fluids, a large part of which was fruit juices. His weight upon entering the hospital was 147 pounds and on leaving the hospital three weeks later 146 pounds.

It was necessary to remove and replace the splints three times during his stay in the hospital. Immobilization of the larynx was fairly complete, although the patient swallowed at times unconsciously. Atropin was given when there was excessive saliva in the mouth.

The patient was discharged after three weeks and was symptom free. The swelling had subsided completely and there was no crepitus. The X-ray report by the radiologist, who had previously reported a fracture of the larynx, was that the fracture appeared completely healed and in good position. I was unable to detect a fracture in the first radiogram or a healed fracture on the last radiogram.

Fractures of the larynx are infrequent, very few cases are reported in the literature. Three cases have been reported in the past five years. Sharpe reported a case of compound fracture of

the larynx and recovery. Conwell reports a case of fracture of the thyroid cartilage with symptoms like the case here reported.

Warren reported a case of fracture of the larynx with injury to the false cords and arytenoids. Roentgenologists reported fracture of the anterior surface of the thyroid and a suspicious area around the cricoid cartilage in Warren's case.

Stimson reviewed all cases reported up to 1900. There were sixty-seven cases in all and death occurred in 80 per cent and was due to edema of the glottis or vocal cords, suffocation or bronchopneumonia.

Fracture of the larynx is caused by direct violence as in hanging, choking or a blow on the larynx. Compression backward against the vertebral column usually causes the break. Fractures are more common in adults and in men. The thyroid cartilage because of its size and prominence is most frequently the cartilage fractured. Fracture may result in any part but is usually dorsal and may involve only the horns. They may be simple or compound. The arytenoids may be loosened from their attachment to the cricoid. The soft parts may be extensively involved in the injury. If the mucosa is torn emphysema may result. This may reach to distant parts of the body.

Symptoms depend upon the location and extent of the fracture. They are: deformity, abnormal motility, crepitus and difficulty in swallowing and speaking. There is usually considerable shock accompanied by temporary loss of consciousness. Difficulty in breathing even to dyspnea and asphyxia may appear early, and lessen only to return later and become more severe.

Hemoptysis often occurs and is an unfavorable symptom. When emphysema occurs it may spread and tissues of the entire body may become invaded. This is a most serious symptom. Laryngoscopy may reveal swelling, congestion, hemorrhage, dislocation of the arytenoids and injuries to the vocal cords.

First aid treatment consists in keeping free passage for air to the lungs. In all cases suspected of fracture, one should be prepared to do a low tracheotomy and this should be done at the first sign of dyspnea, which may not only occur immediately but may come on after several days.

The patient should be placed in a quiet room in which the air is warm and moist. Ice should be applied externally and opiates given to relieve the pain and apprehension. There should be absolute rest to the voice and fluids should be given subcutaneously or by rectum. After the imminent danger of death is over, subsequent symptoms should be treated as indicated.

CONCLUSIONS.

1. Fracture of the larynx while rare is not as rare as indicated by lack of reports in the literature.
2. The thyroid cartilage because of its size and prominence is the cartilage most often injured.
3. The thyroid cartilage is more susceptible to fracture if it is abnormally large and prominent.
4. One must be prepared to do a low tracheotomy during the first week following the injury.
5. Hemoptysis, dyspnea and emphysema are bad prognostic signs.
6. The mortality is high, 70 to 80 per cent.
7. Immobilization of the larynx is sometimes necessary to produce cartilaginous union.
8. Roentgenology so far has not been satisfactory in aiding diagnosis, but should be used in all cases involved in litigation.

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XLI.

ADENOIDS AND UPPER RESPIRATORY DISEASE (COMMON COLD) IN ADULTS.*

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Introduction.—Over a quarter of a century ago Barstow¹ lamented the fact that the subject of adenoids in adults had been much neglected in the literature. It is noteworthy that the situation has changed very little, if at all, since then. In the more limited field of the relationship of adenoids to upper respiratory disease reference may be made to the work of the following authors: Macdonald,² in 1897, believed that whenever there is a constant tendency to cold-taking, or there is chronic laryngitis or bronchitis, and the patient is under 30 years of age, there should be no hesitation to operate for adenoids. In the same year Arrowsmith,³ after a clinical study of 701 cases of adenoids, observed in 2,000 dispensary patients, recorded that difficulty in nasal respiration rather than colds was associated with the presence of adenoids. Corwin,⁴ in 1900, summed up the chief factors that had been named as causes of adenoid tissue hypertrophy thus: age, sex, heredity, scrofula, the lymphatic temperament, frequent colds, nasal deformities, acute infectious fevers, microbes, climate and social conditions. Hughes,⁵ a year later, regretted that the practitioner as well as the specialist frequently failed to recognize the important part that adenoids played in adult life in the production of ear, nose and throat disease. Two years later Barstow¹ presented 57 cases, 27 males and 30 females, 20 to 47 years of age, of adenoids that were operated on. Thirty-five cases showed nose and throat symptoms from nasal obstruction

*From the John J. Abel Fund for Research on the Common Cold, and the Department of Biostatistics (Paper No. 166). School of Hygiene and Public Health, The Johns Hopkins University, Baltimore, Maryland.

The nasopharyngeal examinations were performed by Dr. J. J. Chisolm and Dr. S. W. Egerton, associate and instructor in Clinical Laryngology, respectively.

to chronic laryngitis. Of all of the 57 cases, cure followed in 23, improvement in 29, and no improvement in 4 (otitis media). The results in one case were unknown. Fox,⁶ in 1909, wrote of the frequency of appearance of adenoids in adults and of his successes following operation. In 1928 De Swiezynski⁷ of Poland divided 350 soldier patients, 21 to 23 years of age, into four groups,⁸ according to the amount of adenoid tissue hypertrophy. One hundred patients were in the "service interne" and 250 in the "service otolaryngologique." The appropriate facts may be conveniently tabulated as shown in Table I.

TABLE I.

Distribution of 350 adults of two services, "interne" and "otolaryngologique," with adenoids (a) present, and (b) absent. (De Swiezynski's data.)

Service	Patients with Adenoids		Total
	Present	Absent	
"Interne".....	22*	78	100
"Otolaryngologique".....	98†	152	250
Total.....	120	230	350

*Large, 0; medium, 4; small, 18. †Large, 21; medium, 40; small, 37.

An application of the theory of probability⁹ reveals that there is an association which is significant. That is, the two service groups are different with respect to the presence of adenoids. Or, in other words, young soldiers in the "service otolaryngologique" are more likely to have adenoids than their comrades in the "service interne." In 1929, Nelson,¹⁰ in his presentation of nineteen cases of adenoids in adults, was convinced that adenoid tissue hypertrophy, when present, is as maleficent in adults as in children.

Present Study.—It is the object of the present paper to determine if there is any association between the presence of adenoids and (1) frequency, (2) severity, and (3) type of attack of upper respiratory disease (common cold) in a group of adults. The basic material consists of a part of the enrollment records and a part of the upper respiratory disease symptomatology records of 317 of the individuals that agreed to participate in a study of

the common cold. The individuals whose records are used were students of the School of Medicine or students or staff members of the School of Hygiene and Public Health, the Johns Hopkins University. The period of observation of thirty-five weeks began September 29, 1929, and ended May 31, 1930. Methods and other details that will not be repeated here will be found in the publications of the John J. Abel Fund for Research on the Common Cold, and particular mention is made of Doull *et al.*,¹¹ Gafafer,^{12 13 14} and Palmer.¹⁵ The age distribution of the 317 adults of both sexes with (a) adenoids present and (b) adenoids absent is given in Table II. The age range has a lower limit of 17 years and an upper one of 59 years.

TABLE II.

Age distribution of 317 adult males and females with adenoids (a) present, and (b) absent.

Age group (years)	Adenoids Present*			Adenoids Absent†		
	Male	Female	Total	Male	Female	Total
Total.....	199	36	235	53	29	82
15-19.....	4	0	4	3	2	5
20-29.....	174	25	199	45	20	65
30-39.....	16	8	24	2	5	7
40-49.....	5	3	8	3	1	4
50-59.....	0	0	0	0	1	1

*Tonsils present, 123; partially removed, 34; completely removed, 78.

†Tonsils present, 7; partially removed, 19; completely removed, 56.

Frequency of Attack.—Table III gives the distribution of the number of attacks of upper respiratory disease reported during the thirty-five weeks by the individuals with and without adenoids, respectively. Of the individuals with adenoids present, 49 per cent reported fewer than three attacks and 24 per cent reported more than three; of those with adenoids absent, 40 per cent reported fewer than three attacks and 32 per cent reported more than three. A probability test¹⁶ indicates that there is no significant difference between the two groups with respect to frequency of attack of upper respiratory disease.

TABLE III.

Distribution of number of attacks of upper respiratory disease (common cold) reported during 35 weeks by 317 adults with adenoids (a) present, and (b) absent.

Number of Attacks	Adults with Adenoids Present*		Adults with Adenoids Absent†	
	Number	%	Number	%
0	26	11.1	4	4.9
1	37	15.7	9	11.0
2	52	22.1	20	24.4
3	63	26.8	23	28.0
4	36	15.3	17	20.7
5	12	5.1	4	4.9
6	5	2.1	2	2.4
7	3	1.3	1	1.2
8	0	0.0	2	2.4
9	1	.4	0	0.0
Total.....	235	100.	82	100.

*The source of 594 attacks. †The source of 241 attacks.

Severity of Attack.—In bed, general aching, fever and duration of attack of ten days or more were chosen as indices of severity. classified according to these indices, reported during the thirty-five weeks by the individuals with and without adenoids, respectively. There is no significant difference between the two groups with respect to any one of the four indices of severity.

TABLE IV.

Frequency (per cent) of attacks of upper respiratory disease (common cold), classified according to certain indices of severity, reported during 35 weeks by 317 adults with adenoids (a) present, and (b) absent.

Index of Severity	Adenoids Present	Adenoids Absent
Total attacks.....	594	241
In bed.....	13.1	14.1
General aching.....	13.8	17.0
Fever* { first 48 hours†.....	14.0	16.2
{ later.....	7.2	7.1
Duration 10+ days.....	57.2	58.1

*Includes cases stating fever, whether or not a thermometer was used.

†That is, on the first or second day of illness, or both.

Type of Attack.—Table V exhibits the frequency (per cent) of attacks, classified according to type, reported during the thirty-five weeks by the individuals with and without adenoids, respectively. There is no significant difference with respect to any one of the different types of attack.

TABLE V.

Frequency (per cent) of attacks of upper respiratory disease (common cold), classified according to type, reported during 35 weeks by 317 adults with adenoids (a) present, and (b) absent.

*Type of Attack	Adenoids Present	Adenoids Absent
Total attacks.....	594	241
Cor+ C— ST—.....	17.8	16.6
Cor+ C+ ST—.....	14.3	10.8
Cor+ C— ST+.....	23.1	26.6
Cor+ C+ ST+.....	40.6	39.4
Cor— C+ ST+.....	0.7	3.3
Cor— C+ ST—.....	0.8	0.8
Cor— C— ST+.....	2.7	2.5
Presence of:		
Coryza	95.8	93.4
Cough.....	56.4	54.4
Sore throat.....	67.0	71.8

*Cor=Coryza (sneezing, nasal discharge, nasal obstruction, and/or eyes inflamed or watery).

C =Cough.

ST=Sore Throat (pharynx, nasopharynx, tonsils and/or trachea),

+ =present,

— =absent.

SUMMARY.

1. A group of 317 adults was observed for thirty-five weeks from September 29, 1929, to May 31, 1930, when an effort was made to secure reports of all attacks of upper respiratory disease (common cold).

2. Of these adults, 235 showed adenoids and 82 did not.

3. The group with adenoids present and the group with aden-

oids absent showed no significant difference in respect of (a) frequency, (b) severity or (c) type of attack of upper respiratory disease (common cold).

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9. The *chi-square* is 9.38, which is equivalent to a probability of .0022. See Pearl, R.: Introduction to Medical Biometry and Statistics, 2nd ed., Philadelphia (W. B. Saunders Co.), 1930, pp. 317-322; and Yule, G. U.: An Introduction to the Theory of Statistics, 8th ed., London (Charles Griffin & Co.), 1927, pp. 388-389.
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XLII.

DEAFNESS, HEPATIC DYSFUNCTION, PANCREATIC
INSUFFICIENCY: A CLINICAL ENTITY.

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NEW YORK.

So that the reader will know what has preceded this presentation and be aware of the continuity of this inquiry, he is referred to the author's discussion of the work of Rowland and Rowe on "Contraction of the Visual Fields" (Transactions of the American Academy of Ophthalmology and Oto-Laryngology, 1929, pp. 108-132; "Contribution to the Etiology of Progressive Deafness" (Gottlieb), Laryngoscope, February, 1930, Vol. XL, pp. 85-98); "Deafness Due to Pancreatic Insufficiency" (Gottlieb), Transactions of the American Academy of Ophthalmology and Oto-Laryngology, 1930, pp. 386-418); "An Aural Syndrome of Hepatic Origin" (Drury), ANNALS OF OTOTOLOGY, RHINOLOGY AND LARYNGOLOGY, June, 1931, Vol. XL, pp. 415-433.

The present work encompasses a study of cases of nonsuppurative deafness. Attention was focused on clinical and laboratorial data culled by a careful study of the histories and objective measurements obtained by the application of modern laboratory methods.

The items in the history which were scrutinized are age of onset, duration, the rapidity with which the deafness occurred, the character of the disturbance in hearing, tinnitus, vertigo, falling, blurring of vision, fatigue, headache, appetite, constipation, diarrhea, eructations, pyrosis, flatulence, fullness and discomfort after eating, abdominal pain, and foods that aggravate the condition.

The physical examination included appearance of the ear drums, audiometry before and after inflation, integrity of the paranasal sinuses, tonsils and teeth, the presence or absence of

nystagmus and a general survey of the body. Inquiry about the labyrinthine function was done only when indicated.

The laboratory supplied the following data :

- Examination of urine.
- Wassermann.
- Blood count.
- Basal metabolism.
- Galactose tolerance test.
- Blood sugar.
- Icteric index.

Duodenal contents for status of liver and pancreas by methods devised by McClure.

The present analysis is based upon the study of forty-nine consecutive cases. Only three cases from previous groups have been included, as they were re-examined and brought up to date. Forty-two cases were found to have a definite hepatic dysfunction, and of these, seventeen had in addition a pancreatic insufficiency. Using this as a basis, a statistical inquiry reveals the following data :

Age of Onset.—With most people the age of onset is indefinite. With some, the tinnitus was evident some time before difficulty in hearing became manifest. In others, the deafness was noticed before tinnitus became a symptom. The age of onset was recorded as accurately as one could from the statement of the patient. We are convinced that the onset occurred earlier than the time set in the record. Nine cases had their inception in the second decade, the earliest was at the age of fourteen and the latest at twenty. Twelve cases began in the third decade. Eleven cases had their onset in the fourth decade, four in the fifth decade and six in the sixth and above.

Duration.—From a comparative study of the records, the intensity of the hearing loss bears a direct relation to the duration of the deafness. This, however, depends largely upon the intensity of the liver and pancreatic involvement. It seems that a more rapid depreciation in hearing occurs in cases that have their onset in the early decades.

The character of hearing loss may not be different from the deafness due to other causes, but certain elements are worth

noting. In some instances the patient is not aware of a hearing loss until suddenly the fact is realized by some such incident as inability to hear the door or telephone bell or difficulty in hearing over the 'phone. When in groups such a patient will not be able to sense all of the conversation. Some patients notice a difficulty in hearing with one ear for a long time. At the same time such persons believe that the other ear is perfectly normal when this is really not the case. When the hearing loss is slight, a common complaint is that the difficulty to hear is due to the fact that people mumble or talk under their breath. People who are fond of music and understand how it should be appreciated very often complain of sound distortion. Those who play stringed instruments and have mild hearing loss are unable to tune the instrument properly in the higher tones.

The cases that form the basis for this study have had their hearing examined with the 2A Western Electric audiometer. As a generalization, there is an earlier and more rapid loss in the ability to hear the higher tones than in the rest of the tone scale. The typical early case maintains normal hearing for the low notes up to or between 512 and 2048, then there is evidence of a lessening acuity for notes above this area. As the hearing loss progresses, the acuity for hearing of the high notes gradually diminishes until total losses of hearing are encountered first with the highest note and then successively with those whose frequency is less. The ability to hear the low notes is maintained for a longer time than the higher notes. Later, the ability to hear the lowest notes disappears, but the acuity for hearing tones between 512 and 2048, particularly 2048, is maintained for a longer period than other notes. An occasional patient will have a sharp drop in the low notes at the start. These audiograms as well as the other hearing tests were not done in a soundproof room. However, when disturbing noises occurred, the tests were stopped until the additional noises abated.

The patients were also tested for air and bone conduction with the 256 D. V. fork. The normal for this fork (not in a soundproof room) is 15 seconds for bone and 22 seconds for air. In one of the forty-two cases in question, testing with this fork was omitted. The result of this testing in the remaining forty-one

cases is that in eighteen the bone conduction was prolonged, in seventeen the bone conduction was shortened and in six it was found to be normal. In two of the shortened cases no bone conduction was perceived. It is not believed that the above has constructive significance because, as pointed out by Knudsen and Jones (*Archives of Otolaryngology*, April, 1931, Vol. 13, No. 4), prolongation of bone conduction is rarely observed when patients are examined in a soundproof room.

The effect of inflation on the hearing curve in these cases is peculiar in so far as at times the hearing was improved in most of the frequencies after inflation. On the other hand, taking the same patient at another time, the hearing was decidedly depressed in all frequencies or only in a few of the tones, or the hearing for some tones was improved while other tones were depressed. In other words, as was stated in another communication, inflation in the type of case under consideration has no diagnostic value. It has value, however, in cases of impaired hearing due to scarring from a previous middle ear suppuration. When, in such a case, constitutional factors depress the hearing further, it has diagnostic and therapeutic value. The question of inflation as a general proposition deserves some consideration in view of the recent work of Hughson and Crowe (*Journal American Medical Association*, June 13, 1931, Vol. 96, No. 24), who, using the method described by Wever and Bray, have determined that the membrane of the round window acts as a safety valve in absorbing about 50 per cent of the sound coming to the ear, as a protection for the cochlea. When the membrane of the round window is compressed it increases the auditory acuity for sounds from 512 to 4096. It may be adduced from this that most of the improvement in hearing which is experienced as the result of inflation is due to a sustained increase of air pressure after inflation. As soon as the air leaks out of the eustachian orifice or is absorbed, the hearing returns to its original acuity. This is the reason why ears that have wide open eustachian tubes show no improvement on inflation. The majority of the cases herein reported were easily inflated.

Tinnitus.—Only six of the cases under consideration reported that they have never had tinnitus. The percentage of cases that

did experience tinnitus is therefore very high. Some of the cases had tinnitus in only one ear. With most of the patients it was bilateral. The noises were usually more annoying in the ear most affected by deafness. In some of the cases the tinnitus was noticed long before deafness became manifest, while others sensed it after the deafness was perceived. The character of the tinnitus in the various patients varied from a very high pitched whistle to a mixture of tones and noises akin to the rattling of an old truck or riveting machine. A greater amount of hearing loss was observed in those patients who complained of tinnitus which contained the lower notes. A few patients complained that the ear noise occurred synchronously with heart beat. Many said that the sound in the ears was a continuous whistle. When these last were asked to watch the tinnitus carefully, they usually answered that the sound in the ear was undulating, and that when the greatest intensity was noticed it appeared that such peaks were related to cardiac systole. This is probably the case; the tinnitus in such cases as these is due to the expansion of blood vessels coursing through the pathologic auditory organ. During diastole the vessels retract, but the sound produced by the systole is sustained in diminishing intensity through the diastole. This gives the impression of continuity, which is only apparent.

This view is supported by the recent observation of Wegel (*Archives of Otolaryngology*, August, 1931, Vol. 14, No. 2, p. 158), who analyzed the intensity of the tinnitus in his own ear and found that the intensity increased with each cardiac systole.

The tinnitus is very often milder after a cathartic. After judiciously applied physical exercise the tinnitus is increased for a while and then is definitely softened below its original intensity. This very often lasts for the balance of the day. When the digestion improves the tinnitus becomes less annoying.

Tinnitus is augmented by constipation, indigestion and indiscretions in diet. About one-half hour after eating some article of food that does not agree with the patient, the tinnitus becomes annoying. Generally speaking, this follows a meal containing fat. It does not need to be a large amount of fatty food. This increase of the tinnitus is always accompanied by a lessening of the hearing acuity. Tinnitus is made worse by worry, fits of anger, severe

exertion and coitus. It becomes more evident on reclining, but is worse on arising after having slept. It is more manifest when one shakes the head from side to side.

Vertigo.—About 50 per cent of the cases in this group have experienced vertigo from time to time. With the majority the dizziness was mild, not sustained or incapacitating. A small number of these had spontaneous nystagmus. Usually it was not evident when the patient looked directly ahead but became noticeable when the eyes were sharply turned to one side or another, and then vertigo was experienced, or it was increased if it had already existed. An occasional patient complained of becoming momentarily dizzy on taking a mouthful of food at the beginning of a meal. Three of the cases had fallen on several occasions. Vestibular tests were done on these patients. The results showed that all of the reactions were sluggish, delayed or absent. Abnormalities of direction were not encountered. The disturbances of vestibular function were consistently bilateral, although the reactions of one set of canals were often more profoundly affected than the other. In one case not included in this series because the data are incomplete, the patient had suffered with hearing difficulty many years. During recent years she had several attacks which always followed this sequence: clouding of the hearing on the right side for several days; the hearing would then improve and would be replaced by severe vertigo, accompanied by falling and continuous vomiting, which lasted until the patient reclined with the eyes turned to the right. As soon as the eyes turned to the left, the vertigo and vomiting returned. After several days of absolute quiet in bed the symptoms gradually subsided. It seems that the vestibular nerve is affected by the same toxemia as the auditory nerve. The auditory nerve is more sensitive and thus is involved more often than the vestibular nerve. In the case of the patient with quasi-Ménière's disease it would seem that the symptoms are due to spasms of the vessels nourishing the nerves in question—temporary ischemia.

As will be noticed, no effort is made to classify the cases according to the standard nomenclature. The author does not distinguish the cases by saying these are cases of nerve deafness

or chronic catarrhal deafness, or otosclerosis so-called. The view is assumed here that the character of the hearing curve and other signs found in deafness should not be used as a means of making a pathologic diagnosis. The differences in hearing curves in various cases of deafness are due to the accidental location of the lesion or the vagaries of the anatomy of the hearing organ. The best one can say is that the patient is deaf, and if the cause is known it should be named accordingly.

Headache.—Of the forty-two cases in this study, twenty-nine suffered with headache at some time of their lives. In some the pain in the head was intermittent and in others it was continuous. One patient stated that she had headache continuously for ten years. Twelve of the cases suffered with unilateral and seventeen with generalized headaches. The unilateral type was distinctly migrainous. By that is meant, it began with scintillating lights seen with one eye, then dulling of the intellect with drowsiness, blurring of vision or diplopia, pain over one eye which then became a generalized severe pain accompanied by nausea, and finally in some cases vomiting. In the majority of the cases the migraine began many years prior to the onset of deafness. In most of the cases the migrainous character of the headache had ceased some years before hearing loss was manifest. In some it was replaced by simple generalized headache. Patients have complained that cephalalgia impends constantly. McClure has shown that headache of a migrainous character is due to hepatic dysfunction. The author does not assert that all cases having migraine will finally acquire deafness, but the percentage of cases of the deafened that present this symptom is so large that the likelihood of the advent of deafness should not be overlooked. In some of the cases the blurring of vision was very disturbing. One case had three attacks of complete bilateral hemianopsia in nine years. One of these attacks lasted four hours.

Appetite.—The appetite of these patients was good in twenty-eight, fair in five, and nine complained that it was poor. Apparently the appetite is not often adversely affected.

Constipation.—Twenty-eight of the cases complained of constipation, thirteen had diarrhea, six of these had alternating constipation and diarrhea. The constipation is obstinate and cathar-

tics are the only means of relief. It antedates the advent of hearing difficulty by many years. Patients who have diarrhea usually acquire it late in the illness. A number of patients have two to three loose movements daily. This is not normal, although the patients think it is so.

Belching, Etc.—Belching was a complaint in twenty-six of the cases. It usually occurs after meals. It begins before the advent of deafness. Pyrosis was noted twenty-one times. It usually is an early symptom, but not as frequent as belching. Flatulence is a very common symptom. It usually precedes the deafness for many years. It occurred as a complaint thirty-one times. Fullness and discomfort after eating, lasting from one to four hours, was observed twenty-six times. Occasionally the discomfort was intense enough to be considered pain.

Disturbing Foods.—Some of the patients complained that certain foods make them sick, increase the tinnitus and make the hearing disability more profound. Foods that commonly disturb these patients are chocolate and ice cream. A great many of the patients say that they do not eat fatty foods. They do not know why they have a distaste for such foods. Either a forgotten incident in which a severe upset occurred following taking a fatty meal precluded further experiments along that line or the dislike for fats is fundamental and intuitive. Chocolate and ice cream contain considerable fat.

Fatigue.—Fatigue is a common symptom. When mild, the patient complains of a disinclination to get out of bed after awakening. After rising and moving around this gradually disappears not to return during the rest of the day. With others it comes on directly after lunch and remains the rest of the day. These two types of fatigability may be combined and in that instance the patient muddles through the day by sheer will power. Every now and then the desire to recline is very intense, and when possible these patients do take periods of rest. In some instances, when the patient is partaking of a particularly elaborate meal, he suddenly feels a great senes of fatigue accompanied by yawning and sleepiness and must excuse himself from the festive board to lie down and in a few minutes is fast asleep.

PHYSICAL MEASUREMENTS.

Weight.—The weight and height measurements of thirty-five of these patients were recorded. Comparing these figures with the sex and ages, we have concluded that eleven had normal weight, ten were underweight, and fourteen overweight. The greatest amount in pounds that one of the patients lacked was thirty-two, and the greatest amount overweight over the standard figures was fifty.

Basal Metabolism.—Basal metabolism was done on thirty-six of the forty-two patients in question. Thirty-one of these recorded basal rates on the minus side, two on the plus side and three recorded plus-minus figures. Fourteen of those on the minus side had basal rates below $+10$. The lowest basal rate encountered was -34 . After studying the other data in this case the conclusion was finally reached that this case was suffering with adrenal failure, which had nothing to do with her deafness or hepatic dysfunction. The next lowest basal rate was -15.7 . Unless such figures were associated with other findings, such as disturbances of menstruation, blood pressure, pulse, blood count or galactose tolerance, it was considered part of the picture without complication. It is felt that the two cases that gave plus basal rates were not basal when the tests were made. A lowered basal rate may be considered one of the consistent findings in this disease.

Galactose Tolerance.—The galactose tolerance was performed on thirty-four of these cases. The method used was that described by Rowe (Archives of Internal Medicine, 1924, 34, 388, and Journal American Medical Association, 1927, 89: 1403). The tolerance was normal in twenty-four. In two cases it was $+33\frac{1}{3}$ and in two cases $+66\frac{2}{3}$. In five cases it was $-33\frac{1}{3}$ and in two $-66\frac{2}{3}$. As the result of a study of other data available in each individual case, it was concluded that the cause of this abnormality was as follows:

Ovarian dysfunction.....	4 cases
Pituitary, anterior lobe dysfunction.....	2 cases
Adrenal failure.....	2 cases
Pituitary, posterior lobe hypofunction.....	1 case
Undiagnosed	1 case

It was not felt that these states are complications of the liver and pancreatic disturbance, but coincidental abnormalities which have nothing to do with production of the deafness. This is based on the experience that exhibition of glandular extracts in these cases had no effect upon the progress of the deafness, although symptoms related to endocrine disturbance were influenced favorably. It may be stated that a normal galactose tolerance should be expected in simple cases of liver and pancreatic disturbances associated with deafness.

Blood Sugar.—The blood sugar was estimated in thirty-eight of the cases. Twenty-two hepatic cases were found to have a tendency to low sugar values in twelve cases and figures in between the low and high normal in ten cases. In sixteen cases of hepatic dysfunction with pancreatic insufficiency, the opposite was found to be true, low values were found in only five, and in eleven blood sugar figures ranged between the low and high normal figures. This is contrary to the statement made by the author in his previous paper. He then stated that the blood sugar figures were found in many cases to be above the high normal figure.

Icteric Index.—The icteric index was added to this inquiry as a possible important item for the purpose of determining whether or not bile pigment was retained in the body as the result of the inability of the liver to excrete completely the products of erythrocyte destruction. It was performed on fourteen of the cases. Six of these gave figures above the high normal figures. The normal is 4-6 mgm. per 100 cc. A latent condition of jaundice exists when the figures range between six and sixteen. The small number of cases examined and the small percentage of cases giving abnormal figures allow for no generalization.

Blood Count.—The blood count was performed on thirty-seven of these cases. Twenty-two cases of hepatic dysfunction showed no other abnormality than an increase of small lymphocytes in sixteen cases, the highest count being 50 per cent. Of fifteen cases of hepatic dysfunction and pancreatic insufficiency, eleven showed an increase in the percentage of small lymphocytes; the highest count was fifty-five. This finding seems to be consistent

with the condition in question. It is also noted in disturbances of the glands of internal secretion.

Wassermann.—The Wassermann reaction, with the exception of one case, was negative. One is, therefore, justified in stating that syphilis as an etiologic factor in this disease can definitely be eliminated.

Urine.—The urine was found to hold a great deal of indican in the majority of the cases. In some instances casts were encountered but not in a sufficient number of cases to warrant deductions.

Blood Pressure.—The blood pressure and pulse values are dependent upon so many internal and external factors that it was felt that an analysis of the magnitudes would be futile. It may be said that except in the cases wherein endocrine disturbances were encountered, the blood pressure and pulse rate followed along the conventional figures for the age and general condition of the patient.

Nose, Throat, Ears and Teeth.—In all these cases an inspection was made of the nose, throat and ears. More than 90 per cent of the patients had had their tonsils removed before consulting me. In no instance did the patient say that the tonsillectomy helped the deafness. Quite to the contrary, many patients averred that the difficulty in hearing became rapidly worse thereafter. Some of the cases had submucous resections performed. Others had one or more sinuses operated upon. Postnasal discharge was a very common finding and complaint. There is no doubt that these patients have been swallowing infected mucopus for many years. What relation this has on the advent of digestive disturbance is difficult to evaluate. However, it may be a significant factor in the production of gastrointestinal pathology. There is nothing distinctive about the appearance of the ear drums in these cases and others that I have examined. In some instances the drum membranes appeared perfectly normal, in others there was a definite retraction with absence of luster. In this series there were two cases in which the drums were scarred and distorted due to previous suppuration. In these a modicum of deafness existed before the digestive symptoms became manifest. Then the difficulty in hearing became rapidly worse. Some of the cases

had many decayed teeth and gum infections, others had the majority of the teeth extracted. It was surprising to find young people in the third decade of their lives wearing artificial teeth. In some instances the teeth were well preserved, even in the aged.

Duodenal Contents.—As indicated in the early part of this article, out of forty-nine cases of deafness examined, forty-two had evidence of a hepatic dysfunction, and seventeen of these had in addition a pancreatic insufficiency. The remaining seven cases were thought not to come within this category and will be discussed later. The hepatic and pancreatic evaluations were made according to the method of McClure (McClure, Jones, Chester & Reynolds, *American Journal of Medical Sciences*, May, 1924, No. 5, Vol. CLXVII, p. 649, and *American Journal of Medical Sciences*—McClure—186:300, 1928). All of the directions of Dr. McClure and his co-workers were faithfully executed. Of twenty-five cases of hepatic dysfunction (Chart 1) the highest figures for trypsin was 6.6 mgm. and the lowest was 3. The minimum normal is 2 up. In four of the cases the amylopsin was below 1.5. The minimum normal for amylopsin is 1 up. The steapsin moiety was below 1.5 in eleven cases (minimum normal, 1 up). It is the author's belief that the minimum normals as set forth by McClure are entirely too low. On the liver side we find twelve cases in which the cholesterol figures were below normal. The furfurol number was below normal in twenty-two cases. Alcohol soluble bile pigment was below normal in nineteen cases. In seven only traces were found. In all of the cases alcohol insoluble bile pigment was found below normal and six of these had only traces.

Seventeen cases of hepatic dysfunction (Chart II) had in addition a pancreatic insufficiency. In nine of these the trypsin portion was below 2.0. In twelve, the amylopsin was found to be under 1.0. In fifteen the steapsin was below 1, and two of these displayed no fat splitting enzyme. The cholesterol figure was below normal (30) in sixteen. Of these ten showed only traces. The furfurol number was below normal (80-100) in seventeen; nine of these had only traces and four had none. Alcohol soluble pigment was below normal (7) in all, and of these, five showed only

traces and in two cases none was found. The alcohol insoluble pigment was below normal (8) in all; eleven of these had only traces, and in five it was entirely absent.

It is important that the reader be informed that the author made an error in his previous article, "Deafness Due to Pancreatic Insufficiency." He stated there that the tryptic moiety was more commonly reduced than the other pancreatic enzymes. This was due to the fact that the methods used for the quantitative determination of the activity of the pancreatic enzymes were antiquated and the results were taken at their face value. We believe that the methods now used give fairly accurate quantitative values. Even in those cases of hepatic dysfunction without apparent pancreatic insufficiency the figures for steapsin show a tendency to approach the low normal figures in a little less than one-half the number. In the cases wherein the pancreatic enzymes demonstrate figures which lead us to believe that this organ is not performing its proper function in addition to the liver, it is evident that the lipase factor has suffered a greater loss in digestive capacity than the other enzymes, although losses in the other enzymes are frequently encountered. Fifteen out of seventeen cases show figures for steapsin below 1.0, while the number of cases that show reductions for the other two enzymes is less and that for trypsin least.

In both the simple hepatic dysfunction cases and in those with pancreatic involvement, the cholesterol content of the duodenal contents is reduced to a less extent than the other elements quantitated. In one instance the cholesterol figure was exceedingly high. The origin of cholesterol is presumed to be in the tissues of the body, particularly from the destruction of red blood cells. The liver acts as the excretory organ. Its significance in the bodily economy is not known. A diminution of this substance in the bile may be considered as indicative of a reduction of the power of the liver to excrete it. The furfurol number is reduced to a greater extent than the cholesterol. The fact that bile pigments are consistently and markedly reduced in both types of cases speaks eloquently for the assumption that the liver function is impaired. Bile pigments arise from the destruction of erythrocytes in the reticuloendothelial system as well as in the liver. It

is possible that the liver is not capable of excreting such quantities of bile pigments as are necessary for the maintenance of a proper balance between production and excretion.

The interesting observation of Hagens (*Archives of Otolaryngology*, June, 1931, 13, 825), that the peculiar staining of otosclerotic lesions with hematoxylin is due to the presence of iron in the focus may have a connotation of importance suggested by the above findings.

In Mathews' *Physiological Chemistry*, 1925, p. 426 (William Wood and Company), the function of bile is given as follows: "Bile stimulates greatly the digestion of fats by steapsin and holds fatty acids in solution. By its alkalinity it helps to neutralize the acidity of chyme and so makes a favorable medium for the action of trypsin and amylpsin. In its absence, absorption is much reduced. It stimulates peristalsis and absorption, and putrefaction is held in check. It is a natural laxative. Cholesterol is excreted in bile. Bile is the only fluid in the body that dissolves cholesterol."

It is quite evident that the bile of these patients is not normal and does not perform its natural function. This abnormality could easily account for all of the symptoms of which the patients complain. Then if we consider the reduction in pancreatic digestion, our conviction regarding these factors as competent etiologic agents to produce all the phenomena described, including the deafness, is strengthened. It is not known to what extent the other liver functions are impaired. Even if the reduction of function is slight, it certainly must disturb the bodily economy. Priestley, J. T., Markowitz, J., Mann, F. C. (*American Journal of Physiology*, 96:696, 1931), have shown experimentally that the liver not only detoxifies the blood circulating through the portal system but also destroys the toxic substances. An impairment of this function, in addition to the bile abnormality, would certainly produce toxic effects throughout the body and particularly affect the auditory nerve, which is highly vulnerable.

The high percentage of deafness in patients with disturbances of the function of the liver and pancreas cannot be ignored. The author is convinced that hepatic and pancreatic abnormalities have

a definite causal relationship to the deafness. From the experience with this and other series of cases, it would seem that the liver disturbance occurred first and the pancreatic insufficiency was secondary. The actual pathologic process is not known. Deafness with gall bladder disease is exceedingly common. However, hepatic dysfunction exists without the gall bladder involvement. According to statistics, gall bladder disease is not commonly associated with normal liver.

From the findings the thought is engendered that the deafness is probably linked with a disturbance of the digestion and absorption of fats.

The seven remaining cases, shown in Chart III, have among them four with figures from the examination of duodenal bile which here and there are either just below or above the minimum normal standards. Two of these have in addition an endocrine imbalance. Mrs. G. V. has anterior lobe pituitary dysfunction and Mrs. T. H. an adrenal failure. The remaining three cases have satisfactory enzymic concentrations and hepatic figures. No diagnosis was made in one of these cases (Mrs. B. S. L.) ; one has thyroid failure and the other a pituitary dysfunction.

TREATMENT.

The patients from whose histories this analysis was made form a group of cases of deafness that have, in the majority, been treated with all the varieties of therapeutic measures which modern medicine has to offer. Their tonsils have been removed, septa straightened, sinuses exenterated, eustachian tubes bougienaged and inflated, vibratory massage applied to the drum and ossicles, and diathermy administered in one way or another. Most of them had finally been told that further treatment would be futile and they would have to be content with their lot. Such discouraged folk are not susceptible to suggestion. They know from experience that improvements in their hearing occur from time to time without treatment. That this improvement is temporary is also appreciated by them. Before they are willing to admit that a form of treatment is producing results, the increase in hearing acuity must be evident to them and sustained for a considerable period of time. A form of treatment based on the concept herein set

CHART I.

Case No.	Name	Age	Age of onset	Height, Ins.	Weight	Basal rate
1.	Miss A. P.	17	16			— 3
2.	Mr. L. R.	21½	16½	64¾	141	+17
3.	Miss E. R.	45	17	63½	121½	+ 2.6
4.	Mr. C. M.	33	18	65¼	137	— 1
5.	Miss B. E.	24	19	61¾	136	—10.7
6.	Miss S. G.	26	20	62¾	113¾	— 3
7.	Mr. F. M.	43	21	68+	119¼	— 8
8.	Miss M. P.	27	21	61	114	— 2.1
9.	Mr. M. L.	43	23	67	172½	—11
10.	Mrs. F. W.	28	26	60	112	— 7.5
11.	Mrs. E. W.	55	27	63	149	—13.7
12.	Mr. L. C.	39	29	73.8	150	— 5
13.	Mr. R. D.	38	30	65¼	137¼	— 9.7
14.	Miss A. M.	43	31	65½	143	—10.8
15.	Mrs. F. S.	36	33	64	146	+ 5
16.	Miss M. K.	49	34	62½	98½	—10
17.	Mrs. L. W.	44	36		115	—34
18.	Mrs. S. L.	43	37	61½	151¼	—11
19.	Miss N. A.	54	40	67¾	173	— 8.7
20.	Miss R. D.	51	47		143	
21.	Dr. J. D.	58	48	69	182½	—15.9
22.	Mrs. C. M.	57	51	62¼	121¼	— 8
23.	Mrs. M. M.	64	54	61¼	132¾	— 6
24.	Mrs. J. S.	61	57	62	122¾	— 4
25.	Mrs. L. L.	71	61			
Norms.						±10

CHART II.

1.	Miss M. D.	23	14	65¾	105	—11.9
2.	Mrs. M. B.	57	17	63	155¾	— 3.8
3.	Miss A. H.	29	17	63	150	—12.5
4.	Mr. A. F.	29	23	69¾	189¾	— 4.3
5.	Mr. F. S.	31	24	65¼	154	—12.9
6.	Mrs. E. S.	28	26	65	129¾	— 9.7
7.	Mr. J. B.	34	29	65½	128	— 6.8
8.	Mr. J. C.	56	30	70	179½	—15.7
9.	Miss G. W.	39	33	62¼	113¼	normal
10.	Mr. E. D.	46	33	66+	143	—12.4
11.	Mr. J. S.	43	35			
12.	Mrs. C. Mc.	51	37	64	136¼	—13
13.	Miss E. T.	48	38	62¾	111½	—11
14.	Mr. M. G.	45	43	67½	148	
15.	Mr. H. H.	62	47	64½	184¼	—13
16.	Mr. A. S.	64	54	67¾	155	—15.7
17.	Mr. T. S.	72½	67	66¼	150	— 3
Norms.						±10

CHART III.

1.	Miss F. A.	25	15	62¼	128¼	—15.9
2.	Miss L. B.	24	18	55¼	110	—11.5
3.	Mr. B. L.	39	21	70¼	146	— 8
4.	Mr. R. S.	47	27	68¾	145	—11
5.	Mrs. T. H.	33	31	64	100	— 1.6
6.	Mrs. G. V.	45	31	67	165	—11
7.	Mr. B. C.	61	46	66½	164½	— 3.5
Norms.						±10

CHART I.

Blood pressure	Pulse	Wassermann	Blood chemistry		R. B. C. x M.	Blood count
			Sugar mgm. per 100 cc.	Icteric index		H. B. %
114/75	88	negative	86		4,090	80
110/75	90	negative	105		5,090	97
128/90	78	negative	95		4,160	81
118/78	76	negative	85	7	4,800	90
108/60	100	negative	100		4,800	96
110/75	82	negative	100		4,420	87
118/72	80	negative	87	6	5,280	95
140/84	86	negative	102.5	7	4,020	77
97/88	84	negative	90.3	4.8	4,480	96
150/82	84	negative	90.9		5,020	98
114/90	104	negative	117		5,280	91
		negative	90.9		5,620	106
		negative	93		4,720	90
128/84		negative	100		4,080	79
98/66	82	negative	90.9	7.1	4,760	90
124/70	89	negative	101		4,070	79
116/88	68	negative	83	5	4,200	87
118/85		negative	88.8	4.6	5,320	93
125/90		negative				
128/66	66	negative	74		4,480	86
140/90	62	negative	87	8	4,400	76
130/80	84	negative	105		4,080	100
190/108	60	negative	88.8		4,440	84
210/90	84	negative				
			90-100	4-6	5,000	100

CHART II.

102/62	100	negative	100	6.45	4,560	89
140/94	108	negative	102.5	5.6	5,280	90
118/75	72	negative	90.9	5.75	4,640	91
130/75	98	negative	102		5,200	102
130/85	82	negative	90.8		4,560	84
110/80	82	negative	95	6	4,160	76
119/75	76	negative	85	6.9	4,960	100
120/90	63	negative	105		5,640	100
110/65	84	negative	105		4,800	73
105/74	72	negative	90.9		4,960	85
123/85	80	negative	100		4,200	81
125/88	79	negative	95		4,480	80
	72	negative				
140/64	76	4 plus	100		4,920	90
118/64	62	negative	93		4,820	97
145/70	68	negative	100	4.5	4,200	83
			90-100	4-6	5,000	100

CHART III.

138/80	82	negative	95		5,280	93
116/80	74	negative	83		4,320	80
118/80	68	negative	90.8		5,440	98
118/80	68	negative	90.9		4,480	78
112/65	100	negative	100	5.6	4,820	81
110/66	68	negative	89.3		5,100	85
150/92	78	negative	98.7	4.9	5,280	89
			90-100	4-6	5,000	100

CHART I.

Case No.	W. B. C.	Polys. %	Blood count L. L. %	S. L. %	Eos. %	Galactose tolerance
1.	6,400	62	8	30	0	
2.	6,800	62	4	38	0	
3.	5,800	56	4	38	1	normal
4.	8,000	80	3	13	3	normal
5.	4,000	48	4	44	1	normal
6.	8,200	55	4	38	0	-33⅓%
7.	4,000	66	8	24	1	-66⅔%
8.	7,200	64	6	28	0	-33⅓%
9.	6,800	59	8	30	1	-66⅔%
10.	4,600	46	2	50	0	normal
11.	6,000	70	6	22	0	normal
12.	6,400	69	6	24	0	+33⅓%
13.	6,200	62	5	30	1	normal
14.						
15.	7,000	56	7	36	0	-33⅓%
16.	5,000	50	1	48	1	normal
17.	8,200	62	1	31	2	normal
18.	4,800	68	6	25	0	normal
19.	4,600	54	12	30	1	normal
20.						
21.	6,200	61	5	26	7	normal
22.	5,600	57	8	32	1	normal
23.	4,000	48	5	42	2	normal
24.	4,800	48	10	40	0	+66⅔%
25.						
	5-10,000	60-70	5-8	25	1-3	

CHART II.

1.	5,200	57	2	38	1	normal
2.	8,400	75	3	20	1	normal
3.	12,000	69	3	25	2	normal
4.	4,400	45	14	36	3	normal
5.	6,000	73	4	20	1	+33⅓%
6.	4,000	52	3	44	1	normal
7.	4,200	37	7	55	0	normal
8.	5,800	54	5	40	0	normal
9.	6,200	72	2	26	0	
10.	6,400	63	6	28	3	normal
11.						
12.	5,600	60	5	33	0	-33⅓%
13.	7,600	64	4	30	0	normal
14.						
15.	7,600	57	12	28	0	normal
16.	9,200	64	4	30	0	normal
17.	6,400	57	4	36	1	-33⅓%
	5-10,000	60-70	5-8	25	1-3	

CHART III.

1.	5,600	52	6	40	1	normal
2.	4,400	41	8	50	0	normal
3.	4,600	72	4	23	0	normal
4.	5,400	58	3	38	0	normal
5.	5,600	60	2	34	2	-33⅓%
6.	5,600	68	5	19	1.5	+33⅓%
7.	6,200	68	8	20	0	normal
	5-10,000	60-70	5-8			

CHART I.
DUODENAL CONTENTS

Trypsin N. P. N.	Enzymic Concentration		Cholesterol	Purfulol	Bile pigment	
	Amylopsin glucose	Steapsin n/10 NaOH	mgm. per 100 cc.	No.	Alcohol sol. mgm. per 100 cc.	Alcohol insol.
4.6	3.18	1.9	20.0	trace	1.8	1.26
5.5	2.44	1.65	29.8	very faint	3.2	1.36
5.5	2.072	1.2	23.4	58	6.	5.5
5.2	1.83	1.6	43.3	86	7.3	5.
3.63	2.38	1.35	48.1	52	6.	4.8
4.	3.043	1.4	20.9	trace	3.42	trace
4.4	3.85	1.6	43.3	88	6.	5.5
3.4	1.387	1.	41.2	64	4.36	3.63
3.6	2.79	1.35	trace	0	trace	faint trace
5.	2.25	2.05	25.1	41	3.8	3.4
5.71	2.331	2.05	18.04	faint trace	1.5	very faint
4.	1.15	1.02	trace	18	8.	7.5
5.5	1.524	2.1	38.6	62	7.38	6.48
5.5	3.53	1.9	10.8	20	1.17	1.
4.68	2.762	1.35	26.	26	1.4	1.05
3.5	1.2	2.	22.7	trace	trace	very faint
6.3	3.9	1.4	33.3	38	3.42	5.5
5.4	3.914	1.	33.3	faint trace	trace	0
5.	1.624	1.2	108.	92	6.	4.6
6.6	2.072	1.8	43.3	62	6.	4.2
4.8	2.26	2.4	57.7	78	8.5	8.
5.	4.04	1.2	28.8	70	4.3	4.
5.5	1.599	1.8	36.	42	2.18	trace
3.	1.2	1.9	43.3	62	8.7	7.5
3.63	4.375	1.25	41.2	30	8.	5.5
2 up	1 up	1 up	30 mgm.	80-100	7.	8.

CHART II.

4.5	1.3	0.8	20.1	30	1.6	trace
1.4	0.084	0.2	faint trace	0	very faint	negative
1.3	0.101	0.95	trace	faint trace	1.2	trace
1.1	0.06	0.1	trace	negative	faint trace	negative
0.85	0.035	.05	trace	very faint	very faint	negative
2.8	0.509	.5	3.9	trace	2.2	trace
1.9	3.799	.75	very faint	negative	faint trace	very faint
1.0	0.017	0.15	faint trace	faint trace	.068	faint trace
1.1	3.0	.0	trace	trace	negative	trace
2.15	0.095	1.2	3.33	64	6.6	trace
2.1	0.9	0.6	36.	20	4.3	trace
2.1	0.166	0.15	trace	faint trace	negative	faint trace
3.1	0.854	1.6	14.4	trace	1.9	trace
2.5	4.2	.0	29.5	28	5.0	0.7
1.62	0.263	0.25	13.8	faint trace	2.0	negative
4.8	1.342	0.45	very faint	negative	very faint	negative
1.1	0.011	.2	very faint	very faint	2.8	negative
2 up	1 up	1 up	30 mgm.	80-100	7.	8.

CHART III.

8.0	5.055	3.4	72.1	124	20.	16.
6.0	4.391	2.05	50.8	76	26.41	24.
7.5	4.2	1.4	41.2	104	10.6	10.
8.0	3.334	1.7	86.6	138	9.6	8.
8.0	3.27	1.5	62.1	142	8.7	7.8
5.5	1.73	1.0	98.	148	17.1	6.2
			71.	60	8.	8.
7.5	3.89	1.0	61.8	110	9.6	8.
2 up	1 up	1 up	30 mgm.	80-100	7.	8.

forth is looked upon with a great deal of distrust and skepticism. This is quite natural. The idea that deafness could have its origin in organs which are so far removed from the ear seems bizarre and unreasonable. This type of patient therefore is excellent material from which one may expect to obtain honest information regarding the results of treatment.

Not all the patients recorded here received treatment. Some started, and when immediate results were not obtained became discouraged and stopped. Those that have conscientiously followed the treatment have either shown steady improvement in their hearing as well as their general health or the hearing did not become worse.

The method of treatment is the same as that described by the author in his previous report and therefore needs no elaboration here.

In reporting the records that follow, the intention is to portray cases that had their onset in different decades and to give the result of treatment on patients whose deafness has existed various periods of time. Deafness of short duration recovers quickly. Patients in the second or third decade of life are more likely to receive substantial benefits than older people. In other words, the earlier the diagnosis is made, the more likely it will be that satisfactory results will be obtained.

Mrs. L. M.—This is Case 10, described in the Transactions of the American Academy of Ophthalmology and Otolaryngology, 1930, page 397. This patient has been constantly treated from October 25, 1929. The following audiogram will show that her hearing has improved greatly since the report of 1930—in fact, it is now within the limits of normal:

Chart 1, Case 1.—Miss A. P., 17 years of age. Duration, one year. Has tinnitus in the right ear. Becoming progressively worse. Has had arthritis of the feet with rash on legs and hands which lasted about six months. Had an appendectomy in August, 1929. Bowels regular, appetite good. Prior to the advent of deafness had three attacks of nausea, vomiting and abdominal pain. Directly after one of these, her appendix was removed. The appendix did not appear to be pathologic. Her mother is

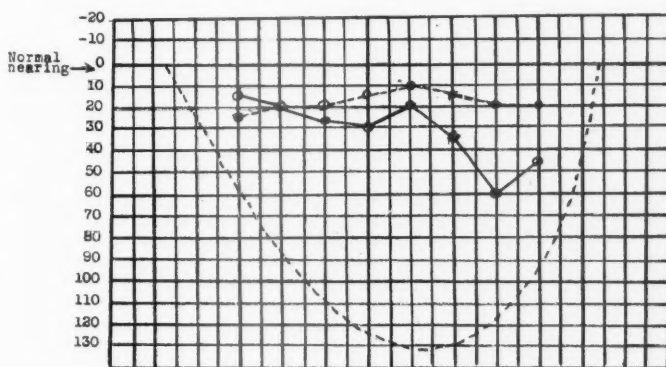
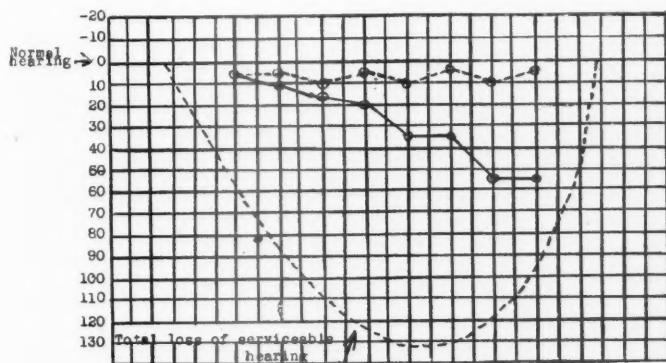
CASE 10.

AUDIOGRAM OF MRS. L. M.

Right ear.

o ——— o October 28, 1929.

o - - - - o June 6, 1931.



32 64 128 256 512 1024 2048 4096 8192
Pitch C C c c¹ c² c³ c⁴ c⁵ c⁶

Left ear.

o ——— o October 25, 1929.

o - - - - o June 8, 1931.

Figure I.

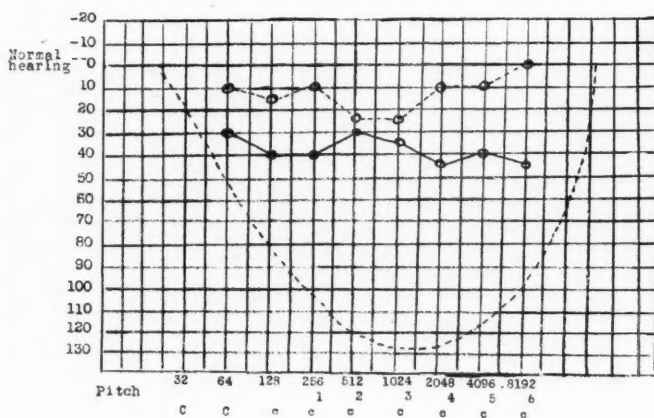
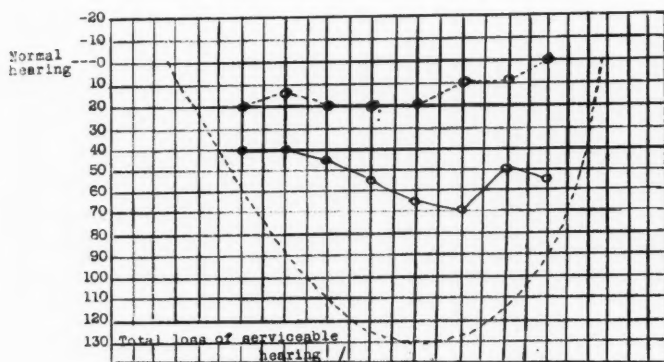
CHART 1, CASE 1.

AUDIOGRAM OF MISS A. P.

Right ear.

o ——— o October 31, 1930.

o - - - - o October 31, 1931.



Left ear.

o ——— o October 31, 1930.

o - - - - o October 29, 1931.

Figure 11.

hard of hearing; her father is blind. Under suitable treatment this patient has gained in weight and has shown a remarkable improvement in hearing. Comparative hearing curves follow.

If it were only for this one case and the result obtained, this work would be amply justified.

It suggests the possibility that there are many adolescent girls and boys who have hearing losses with mild gastrointestinal symptoms which under ordinary circumstances would be doomed to bear the handicap of impaired hearing throughout their lives. It is during these years that the result of treatment gives the greatest promise for recovery.

It is therefore suggested here that all cases of nonsuppurative deafness in young people should have the benefit of the type of examination which is followed here.

Chart 1, Case 10.—Mrs. F. W., 27 years of age. Duration, two years. Has tinnitus on both sides; constipated. During the summer has attacks of diarrhea; flatulent, belches and feels uncomfortable after eating, two days out of each week. Has had these digestive symptoms ever since she was a little girl.

Diagnosis: Hepatic dysfunction.

Under appropriate treatment she has improved in weight, her digestive disturbance has disappeared and her hearing has improved.

Descriptive audiograms follow.

Chart 1, Case 17.—Mrs. L. W., 44 years of age. Duration, eight ears. Was first seen November 1, 1930. Progressive. Tinnitus is a roar and synchronous with heart beat. Has felt tired most of her life. Menses scanty and infrequent. Constipated for many years. Belching and pain in upper portion of abdomen for four years. Flatulent. For fifteen years has felt full for a long time after eating.

Diagnosis: Hepatic dysfunction and adrenal insufficiency.

In addition to treatment directed toward her liver, she was given enteric coated pills of whole adrenal gland. Patient now claims that she no longer is fatigued and hears better.

The following audiograms describe the hearing improvement:

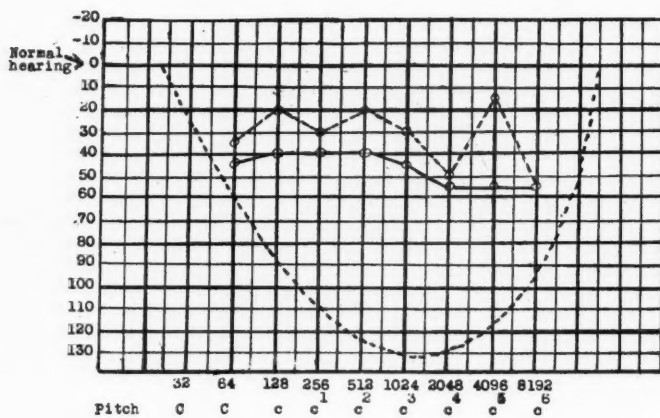
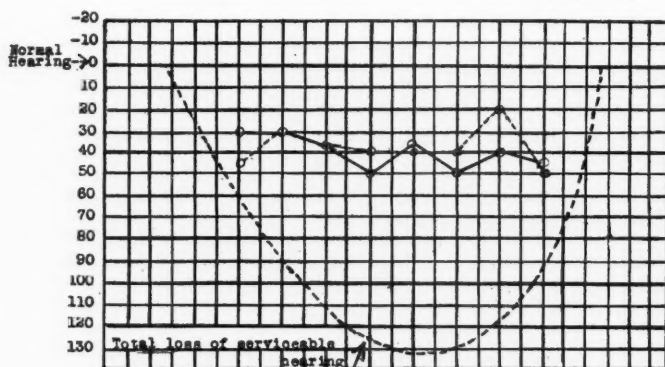
CHART 1, CASE 10.

AUDIOGRAM OF MRS. F. W.

Right ear.

o—o November 10, 1930.

o----o July 22, 1931.



Left ear.

o—o November 10, 1930.

o----o July 22, 1931.

Figure III.

CHART 1, CASE 17.

AUDIOGRAM OF MRS. L. W.

Right ear.

o—o November 1, 1930.

o----o October 9, 1931.

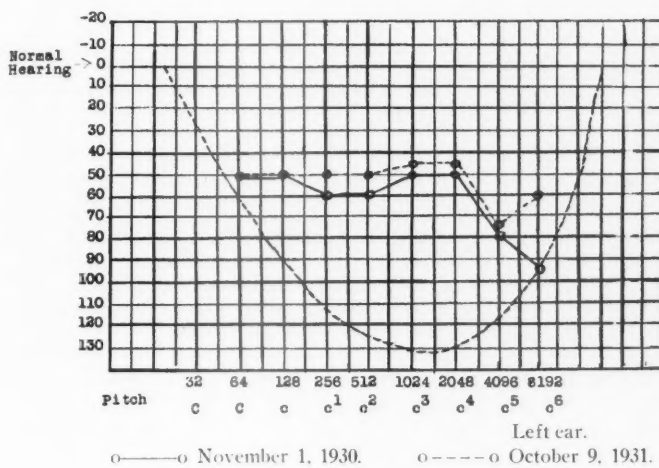
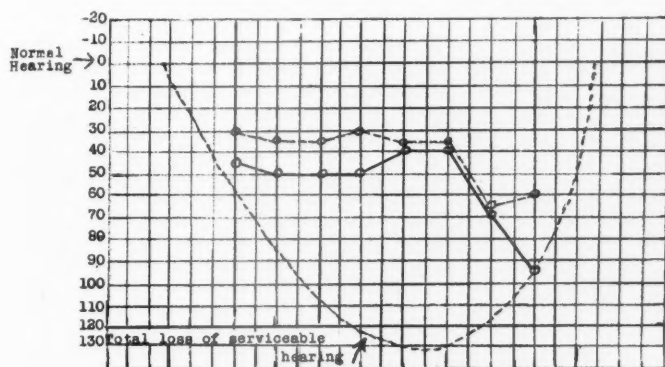


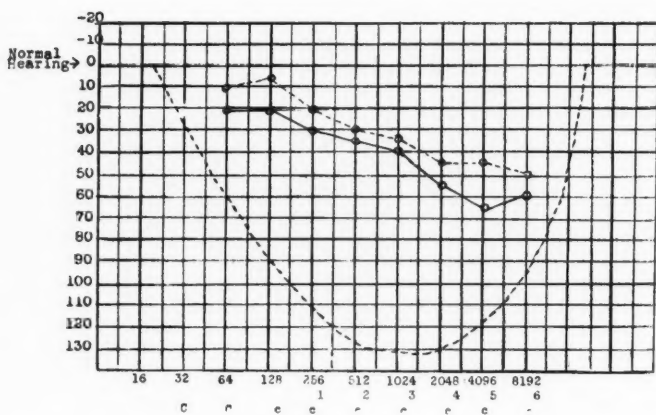
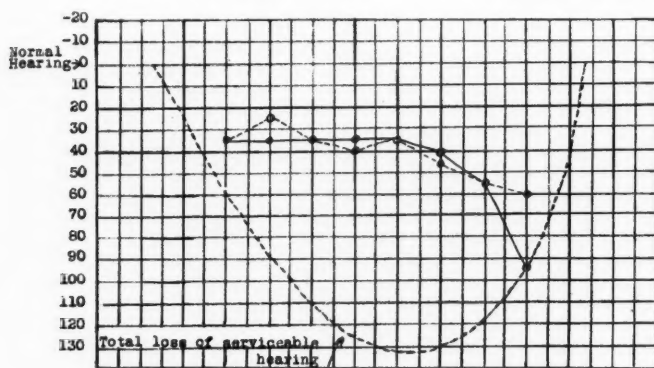
Figure IV.

CHART 2, CASE 10.

AUDIOGRAM OF MR. E. D.

Right ear.

o——o November 29, 1930. o-----o October 10, 1931.



Left ear.

o——o November 29, 1930. o-----o October 10, 1931.

Figure V.

Chart 2, Case 10.—Mr. E. D., 46 years of age. Duration, thirteen years. Was first seen on November 6, 1930. Progressive; sound distortion. Easily fatigable. Migraine. Has had attacks of vertigo, vomiting and diarrhea. Grandfather and father deaf.

Diagnosis: Hepatic dysfunction and pancreatic insufficiency. Under appropriate treatment his health has improved gradually, digestion is normal, headaches do not occur and he says his hearing is better.

Descriptive audiograms follow.

SUMMARY.

In these pages there is described a condition which may be termed "auro-hepatico-pancreatic syndrome," the cardinal symptoms of which may be listed under three headings:

Cranial—Tinnitus, progressive loss of hearing, vertigo, falling, headache (migraine), and blurring of vision.

Digestive.—Constipation, occasionally diarrhea, belching, pyrosis, flatulence, fullness and discomfort after eating.

General.—Fatigue.

The positive objective findings are lowered basal metabolic rate, increase in the number of small lymphocytes in the blood, increased indican in the urine and a definite abnormality in the duodenal fluid, which is manifest by a reduction in the amount of cholesterol, furfurol number, alcohol soluble and alcohol insoluble bile pigments. Traces and total absences of these are frequently recorded. In addition to this, there is a reduction in the digestive activity of the pancreatic ferments, the lipolytic element being most often depressed.

XLIII.

PULMONARY ABSCESS FOLLOWING TONSIL- LECTOMY.

IRA FRANK, M. D.,

CHICAGO.

The report by Richardson,¹ in 1912, of abscess of the lung as a result of tonsillectomy attracted universal attention. Reports of this deplorable and serious complication rapidly multiplied. Fisher and Cohen,² in 1921, added 5 to 71 reported cases. The next year Chipman³ found 100 and added 24 from his own observations and during the same year Moore,⁴ by a questionnaire to 1,020 laryngologists in the United States and Canada increased the number to 202. Since Hedblom's⁵ report, in 1924, of 48 cases encountered at the Mayo Clinic, the number observed has grown so that this form of pulmonary abscess is no longer regarded as a rare occurrence. Hedblom expressed the opinion that the number in 1924 was in the neighborhood of 400.

Most⁶ failed to find lymphatic communication between the tonsillar regions and the lymphatic structures of the lung. His conclusions have been generally accepted. Of the two remaining paths for metastatic infection of the lungs, the blood and air currents, the consensus of opinion has favored the latter, although pulmonary embolic abscesses occasionally develop from detached thrombo following septic tonsillar and peritonsillar thrombophlebitis. Fetterholf⁷ and Fox removed the tonsils of dogs, and after inoculating the wounds with virulent organisms they found infected thrombi in the adjacent veins. Most authorities (Richardson, Homan, Porter, Simpson, Noah, Fisher and Cohen, Fetterholf, Antler, Holman, Schlueter, Mosher and others) not only believe that pulmonary abscesses may be hematogenous, but have reported the actual occurrence of specific cases.

There is considerable proof at hand in support of the view that lung abscesses may be aerogenous in origin. If the pharyngeal and laryngeal reflexes are abolished, foreign material, such as

pus, blood and food particles, will have easy access into bronchi and parenchyma of the lungs. Similarly, during tonsillectomy, clotted blood and shreds of tissue with bacteria are readily aspirated. Myerson⁸ found blood and mucus by bronchoscopic examinations, in the trachea and bronchi of 155 out of 200 patients immediately examined after tonsillectomy. Iglauer found an almost equally high percentage of cases with blood in the tracheo-bronchial tree after tonsillectomy.

Pilot and Davis⁹ have demonstrated that in connection with lung abscess the infections appear to arise largely from the organisms that reside in the mouth and upper respiratory passages.

It is not surprising, therefore, that with these organisms normally about the tonsils and teeth, under certain conditions these bacteria find their way to the lower respiratory tract and give rise to definite lesions.

From their observations they found the spirochete and the fusiform bacillus as the pathogenic agent in the production of lung abscess. However, for the production of a putrid lesion the addition of a pyogen, particularly the streptococcus, is essential.

In connection with this subject, I would like to refer to the work of Minas Joannides,¹⁰ who experimentally produced lung abscess in animals by direct injection into the lung through a bronchoscope. The materials used were fresh dog's blood and abscess sputum, pyorrhea scrapings, bits of teeth and fresh tonsil tissue.

He mentions that aspiration of freshly infected blood following an operation in the nasopharynx has given the highest incidence of postoperative lung abscesses.

Moore¹¹ reports from his study of lung abscesses that the lower lobe was involved in 60 per cent of the cases; the right lung in 31 per cent and the left lung in 19 per cent. After operation under local anesthesia he found pulmonary complications in 19.3 per cent of cases.

The work by Ochsner and Nesbit¹² is of especial interest in this connection.

By injecting the anterior pillars of the tonsil with 15 cc. of a ½ per cent solution of procain the reflex for swallowing was anesthetized and the larynx failed to rise to a point of safety

below the base of the tongue and epiglottis. Under such conditions lipiodol, which was now administered by mouth, entered the air passages when the patient attempted to swallow and was revealed by bronchography. Using a fluoroscopic screen, they were also able to see the oil enter the pharynx and pass on down in the larynx, trachea and bronchi, in five patients who attempted to swallow after tonsillectomy under local anesthesia. These observations are highly important in their relation to controversies concerning the form of anesthesia on the frequency of abscess of the lung after removal of the tonsils. Chevalier Jackson has emphasized the significant and valuable part played by the cough reflex, "the watchdog of the lung," which is present when local anesthesia is used for tonsillectomy, but frequently altogether absent when general anesthesia is employed. The aspiration theory of the origin of these abscesses is also supported by the fact that the epithelial lining of the bronchi is continued as the lining of the abscess cavity. Such a direct communication between the two was found by Ochsner¹³ in a study of the anatomic relations of these post-tonsillectomy abscesses in ten autopsies.

We have thought that an experience of our own in this connection may prove of interest. It illustrates the manner in which blood may be aspirated following hemorrhage after tonsillectomy and also shows how prompt treatment probably prevented a pulmonary abscess.

The tonsils were removed from patient H. S., September 28, 1931, under local anesthesia. A simple operation was performed, occupying only a few minutes. There was only slight bleeding. The following day, however, hemorrhage occurred and it was necessary to suture the wound on the left side, as the ordinary methods of checking the hemorrhage were unsuccessful. At this time the wound on the right side was dry. On the second day bleeding occurred again. It was profuse and constant and continued, notwithstanding treatment with peroxide gargles, hemostatic serum and pituitrin. As there was marked trismus of the jaw, general anesthesia was necessary, and a bleeding vessel was discovered and sutured on the right side. During the afternoon of the second day the patient started to cough and his temperature rose to 103.4 F. The white blood count was 17,300; polymorpho-

nuclears, 81 per cent; lymphocytes, 17 per cent; monocytes, 2 per cent; blood pressure, 132/100. Albumen in urine was present in moderate quantity. On the morning of the third day coughing continued. The fever was between 101 and 102 degrees, and an examination by an internist disclosed bronchovesicular breathing over the right lung, and sonorous and crepitant râles in the left infraclavicular region. The respiratory sounds in the left lower lobe were absent. It was believed that a blood clot had lodged in the left bronchus. The air supply to the lung was obstructed, and consequently this region of the left lung had become atelectatic.

Inhalation of CO_2 was started with the object of stimulating deeper and fuller inspiratory movement. This was continued for intervals of one minute and repeated every fifteen minutes. After the thirteenth inhalation the patient coughed up a fair sized clot of blood.*

The breathing was easier the following day (the fifth day after operation) and the cough diminished. The use of CO_2 was discontinued; respiratory sounds were now heard in the left lower lobe and the fever subsided gradually. He left the hospital at the end of ten days.

We were impressed by the fact that the pulmonary complications probably followed the general and not the local anesthetic. It is apparent from the case history that while hemorrhage occurred following the local anesthetic the pulmonary complication occurred only after the general anesthesia. Are we justified in concluding from a single observation that general anesthesia is more likely to produce pulmonary complication in tonsillar operations than local anesthesia? Upon considering the pulmonary complication it was thought that part of one lung was atelectatic, due to an aspirated clot obstructing a bronchus. It seems significant that the inhalation of CO_2 was almost immediately followed by the expulsion of the clot.

It is apparent that if the clot had remained in situ, grave pulmonary complications would have been inevitable. We are inclined to believe that the inhalation of CO_2 as described was of great value in the treatment of the patient and in the prevention

*This was unfortunately thrown away by an attendant.

of complications. We think that the therapeutic measure is worthy of trial in similar cases, and that it should have a wide range of usefulness in all instances where aspiration has followed anesthesia.

It seems also worthy of trial in those instances where semi-solid substances have been recently aspirated, in order to stimulate respiratory and expulsive movements.

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XLIV.

BRAIN ABSCESS WITH PECULIAR BACTERIOLOGIC FINDINGS.*

W. E. GROVE, M. D.,

MILWAUKEE.

In 1930, O. J. Dixon read a paper before the American Medical Association on "Brain Abscess as the Otologist's Problem." He states an axiom in the treatment of any diseased condition, that "the greatest problem in the successful management of a brain abscess is in the diagnosis of the lesion." The diagnosis of this condition is usually not easy until too late. "There is no pathologic lesion which explodes with such sudden and fatal results." There is no organ in the body in which an abscess produces fewer definite diagnostic symptoms than a brain which harbors an abscess. Particularly is this true if it be in one of the so-called silent areas. As Bagley states, the fear of the presence of a brain abscess frequently prevents the physician from facing the unpleasant situation until the appearance of grave symptoms. The early symptoms are often very vague. Disturbances in other parts of the body are characterized by deformity, inflammation, pain, fever and impairment of function. A large proportion of brain abscesses do not show any positive neurologic signs in their early stages, and the above named signs may be so little apparent in a brain abscess as to pass unrecognized.

In a large series of autopsies, Koerner demonstrated that the brain abscess was adjacent to the original focus of infection in 85 per cent, and, according to Von Bergmann, a primary focus is always necessary in the formation of a brain abscess. Statistics show that over 50 per cent of all brain abscesses are otogenic in origin and of these about 80 per cent are complications of chronic mastoid infection. It is quite evident, therefore, that the genesis of brain abscess is an important otologic problem and ranks with meningitis and sinus thrombophlebitis as one of the three major

*Read before the Middle Section of the American Laryngological, Rhinological and Otological Society, Chicago, January 5, 1932.

complications of ear suppuration. Whether this condition should be handled surgically by the surgeon or by the otologist is of little significance, but occurring, as it often does, at least in its inception, in close proximity to the operative terrain of the otologist it would seem that he is the logical one to handle it. The drainage of the abscess is certainly a minor procedure when its location has been determined, and because of its extension from the ear and its adnexa and the frequent presence of fistulous tracts the approach to it should be easier from the region of its origin.

The symptomatology of this condition is divided into four stages: initial, latent, manifest and terminal. Diagnosis is not usually made during the first two stages, and when made the patient has two classes of symptoms, general and local. Among the general symptoms may be noted lethargy, sallow complexion, slow respiration, loss of appetite and subnormal fluctuations of temperature. His complaints are usually relatively negative except for headache, and this is the most constant and important symptom. This headache is characteristic. It is the headache of increased intracranial pressure. It is constant, unrelieved by any form of medication and becomes progressively worse. Other general brain symptoms usually present are vertigo, sudden vomiting, slow cerebration, bradycardia, photophobia and optic neuritis. This last named symptom is of less frequent occurrence than generally supposed.

In brain abscess streptococci and staphylococci are the predominating organisms and usually in mixed culture with other organisms. These organisms are usually of very low virulence, and according to Leutert this is the reason why a brain abscess develops at all, it being his contention that when the virulence of the organism is high a diffuse meningitis develops from which the patient rapidly succumbs. When the virulence of the organism is low a circumscribed meningitis with sealing of the meningeal spaces occurs, which is followed by an encephalitis in the neighborhood. While pseudodiphtheria and diphtheroid organisms have frequently been encountered in brain abscess cavities, I have not been able to find any other recorded case where the true Klebs-Loeffler organism was recovered.



Fig. 1.



Fig. 2.

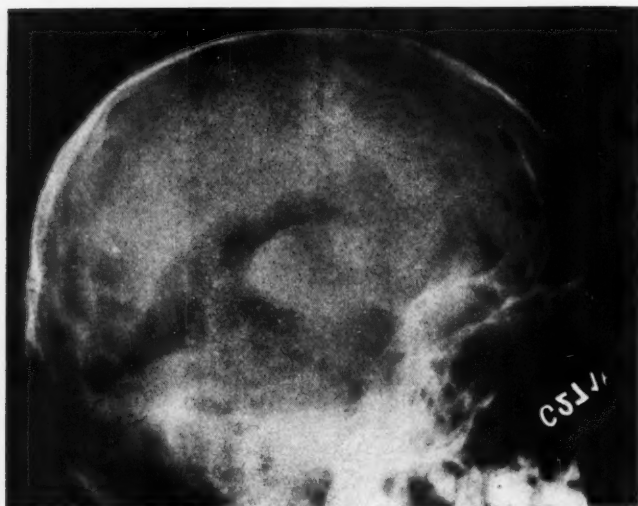


Fig. 3.

CASE REPORT.

Lee Collins, male, aged 8.

History: Admitted to the Milwaukee Children's Hospital October 29, 1930, complaining of pain in the right ear. He had had pain in the right ear for the first time on September 15, 1930, with discharge from the ear on the following day. This discharge continued up to October 27th, two days before his admission, when he again began to have pain in the right ear and headache. His past history and family history were essentially negative. There was no history of previous ear trouble.

Examination: There was moderate tenderness over the mastoid, more marked above the level of the antrum; no edema. There was some congestion of the posterior and inferior canal walls. There was a profuse discharge of foul mucopus coming through a large central perforation. The temperature was 100.8, pulse 20, urine negative, blood culture negative, and the white count was 13,800. The X-ray examination showed a slight blurring of the right mastoid but no definite evidence of bone destruction.

The mastoid tenderness decreased from day to day, and likewise the secretion. On November 13th, the ear was practically dry and no tenderness remained. Sagging of the posterior superior canal wall was at no time present nor any other sign which would demand operative interference. The temperature ranged between 99 and 101 with an occasional jump to 102 during most of his hospital stay. On the last four days it ranged from 97.6 to 99.8, and on November 23, 1930, the day of his dismissal, it was normal.

He was readmitted to the hospital from the outpatient department on December 5th, with the history that after his discharge from the hospital he had vomited every day up to December 2nd and had severe frontal headache. Examination revealed a bilateral choked disc of $2\frac{1}{2}$ diopters.

His temperature was 99.4 and the pulse was 88. He complained of severe frontal headache and general malaise. The condition of the right ear was the same as upon his discharge from the hospital. Spinal punctures were done on December 9th, 22nd and

30th, and for several days after this procedure he was relatively comfortable with an absence of headache.

On December 16th the choking of the discs was about $2\frac{1}{2}$ diopters in each eye. The left vestibular apparatus was stimulated with cold water and the responses from both vertical and horizontal canals were normal. The right ear was not douched because of the large drum defect. X-rays of both mastoids showed no mastoid involvement on either side. Neurologic examination was essentially negative.

A diagnosis of right temporosphenoidal lobe abscess was made. The patient, being in good general condition, surgery was purposely delayed in order that the intracranial process might wall itself off as completely as possible. In the meantime a spinal tap was done on December 22nd for the relief of symptoms.

On December 29th, Dr. Kassowitz made some most beautiful encephalograms, which showed the right lateral ventricle considerably compressed and displaced to the left of the midline. These were made by means of a spinal tap with the alternate withdrawal of fluid and introduction of air. A spinal tap on December 30th showed a cell count of 1262, whereas on December 10th there had been two cells and on December 23rd, three cells.

Operation: On January 3, 1931, with the assistance of Dr. McCormick, the abscess was drained. The incision, beginning above and anterior to the tragus, was carried around the ear to the tip of the mastoid. Elevation of periosteum and division of the temporal muscle. Removal of mastoid cortex over the antrum region to expose the tegmen. The mastoid cells were not infected. Removal of the tegmen antri and tympani and a portion of the squama, exposing the dura of the middle fossa over an area 3×2 cms. As this opening of the skull was made, there was a distinct bulging of the dura into it. The dura was lusterless and gray but no definite granulations were seen and no evidence of a fistulous tract. The dura was incised at this point, and at a depth of about 2 cm. a thin, milky, odorless pus was encountered. About three to four ounces of this pus were slowly evacuated. A rubber tube drain was inserted into the abscess cavity, which was surrounded and covered by gauze dressings.

The wound was dressed in 24 hours under gas anesthesia, and at the same time the left ear drum was incised, an acute otitis media having developed here. Inasmuch as the laboratory reported a growth of Klebs-Loeffler bacilli in the culture from the abscess, 10,000 units of antidiphtheritic serum were injected into the buttocks on January 5th. He developed a very severe local reaction, with some elevation of temperature, which fell again to slightly above normal on January 7th. The wound was dressed on alternate days after January 4th, and usually under a light gas anesthesia, and these dressings were carried out by Drs. McCormick and Wolters. The temperature stayed slightly elevated until January 18, when for some unknown reason it shot up to 103.4. It came down promptly and has remained down ever since. He was dismissed from the hospital on March 1, 1931, in very good condition and with no demonstrable sequelæ of his brain abscess.

Laboratory findings: The laboratory findings in this case are very interesting and as far as I know unique.

January 5th. Culture from pus of the operative wound showed diphtheroids predominating with a few Klebs-Loeffler bacilli.

January 8th. Culture from interior of drainage tube showed diphtheroids and Klebs-Loeffler bacilli, the latter predominating.

January 10th. Culture from drainage tube showed diphtheroids and Klebs-Loeffler bacilli.

January 18th. Culture from wound itself showed Klebs-Loeffler bacilli, diphtheroids and streptococci.

January 15th. Guinea pig inoculation with pus from the brain abscess, inoculated subcutaneously, formed an abscess in four days from which a pure culture of Klebs-Loeffler was recovered. The virulence test of this Klebs-Loeffler bacillus proved to be negative.

COMMENT.

This case is interesting and instructive for various reasons. In the first place, any brain abscess is of interest because it is one of the more rare complications of ear suppuration and because it is sometimes very difficult of diagnosis before the manifest or terminal stages.

Second, otitic brain abscess is a complication of chronic mastoid disease in about 80 per cent of the cases, and in the other 20 per cent it complicates acute mastoid disease. It is, indeed, a very rare thing to have it complicate an acute otitis media without mastoid involvement, as was true in this case.

Third, the laboratory findings alone would make this case of interest. As far as I can find, the Klebs-Loeffler organism has never before been recovered from a brain abscess. When the report of this organism was first returned by the laboratory, I greatly questioned its correctness. The Klebs-Loeffler bacillus is a surface aerobe and has no business in the depths of a brain abscess.

Last, it is surprising that so large an abscess, which displaced the lateral ventricle of its own side past the midline and from which three to four ounces of pus were evacuated should not have produced some localizing signs from pressure, even though it developed in a silent area.

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XLV.

MIXED TUMOR OF THE NASAL SEPTUM.*

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The usual site for mixed tumors is in the parotid region, where they are not uncommonly found. As their name implies, different varieties of tissue elements enter into their formation, such as varying amounts of epithelium, or mesoblast, with, at times, endothelium. The type and quantity of each of these elements varies widely. Reports of fairly large series of these tumors are seen not infrequently in the literature. One of these often referred to is that of Wood,¹ who reports a series of fifty-nine such tumors, finding twenty-six in the parotid area, thirteen in the submaxillary area, four on the lips, four in the pharynx, one in the cheek and two in the neck. He points out that developmental defects are at times found in the same subject associated with a mixed tumor. The incidence of the tumors at the different locations varies somewhat with the series.

Mixed tumors have a tendency to recur after removal. Malignant metamorphosis is so frequently seen amongst them that they should be considered surgically as malignant tumors. Wood¹ states that 30 per cent of them recur and that about 25 per cent are malignant or eventually become so. A mixed tumor of the thyroid cartilage with repeated recurrence and eventual malignant invasion of the neighboring tissues has been recently reported by Lynch.² In a study of malignant tumors of the nasal sinuses Barnes³ included a mixed tumor originating in the lacrimal gland which recurred in the orbit in malignant form twenty-five years after removal.

In the upper air passages and accessory sinuses mixed tumors of parotid type are not common. In an article on developmental tumors of the nose, throat and ear, Meeker⁴ has reported mixed

*Presented as a candidate's thesis to the American Laryngological, Rhinological and Otological Society, 1931.

tumors of the tonsil, soft palate, hard palate and nasopharynx. Two cases of mixed tumor of the soft palate have just been reported by d'Aunoy,⁵ who has gathered together reports of twenty-eight similar tumors at this location with a review of the literature. Diggle⁶ reported a mixed tumor arising from the lateral wall of the nose just anterior to the inferior turbinate. A mixed tumor involving the right choana and nasopharynx was reported by Menzel.⁷ A tumor of the maxillary sinus, reported by Taylor,⁸ proved to be a mixed tumor of parotid type. A careful search of the literature has failed to reveal a report of a mixed tumor of the nasal septum.

Examination of a growth recently removed from the nasal septum because of the obstruction it caused, showed it to be a mixed tumor, parotid type. This tumor occurred in a girl of Italian parentage, aged 14. The following outline of the history is presented:

The family history is unimportant.

The personal history gives no history of unusual irritation or trauma to the nose.

The present illness began about one year ago when she had some nose bleeds and some mucus discharge from the right side of the nose. About three months ago she began to have obstructed breathing on the right side of the nose. Complete loss of airway on the right side gradually came on. For the past two months the nose has been slightly swollen, and upon looking into the nose the parents could at times see a fleshy obstruction there.

Physical examination showed the following positive findings: Anterior cervical glands enlarged somewhat. Tonsils enlarged, scarred and show pus on pressure. Adenoids moderately large. Nasal septum is slightly deflected to the left. Some mucopus is present on the left side of the nose. The right side of the nose shows a fleshy growth about 1 cm. from the external nares, which completely obstructs the passage. It is indented as if the patient had been pushing at it with her finger. The ala of the right side of the nose is somewhat displaced laterally. On transillumination, the right frontal sinus is somewhat darker than the left and the antrums are equal. X-ray of the sinuses shows some veiling of the

right antrum and the right ethmoid, evidently due to a thickening of the membranes. The X-rays are otherwise negative.

Operation: Examination under ether anesthesia showed the growth to be attached to the nasal septum, beginning about 1 cm. from the columella. It measured about $2\frac{1}{2}$ cm. in length by 2 cm. in width by $1\frac{1}{2}$ cm. in thickness. A snare was placed around the growth and it was removed. The tumor was attached at its base to the quadrilateral cartilage except below where it extended somewhat over the maxillary ridge. The attachment to the cartilage seemed to be somewhat roughened. The appearance of the tumor in gross was such that the possibility of a malignancy could not be eliminated.

In order to make the removal of the area of the tumor as complete as possible, and leave no neighboring tumor remnants to start the growth again, the operation was continued as follows: A vertical incision was made on the left side of the septum as in submucous resection. The membranes were now elevated from the left side of the septum. A circular incision was then made on the right side of the septum around the area of the tumor attachment leaving at least a 5 mm. margin of healthy tissue. This incision extended on the right side through the mucosa, perichondrium and likewise through the cartilage to the other side of the septum, and the piece was removed. The maxillary ridge below was removed with forceps. An unsuccessful effort was made to hold the flap of mucosa on the left side of the septum in place with sutures and a perforation resulted. The tonsils and adenoids were then removed.

Pathologic report: The specimen is composed of two pieces of tissue. The larger one is about $2\frac{1}{2} \times 2\frac{1}{2} \times 1\frac{1}{2}$ cm. and composed of fairly firm substance. It is grayish pink in color and covered with a glistening mucosa. On section it shows a more or less uniform appearance but mottled with bluish white islands of rather firm material.

Microscopically the surface is covered with a fairly normal looking stratified columnar nasal epithelium containing mucous glands, but which varies from this to a low simple columnar epithelium.

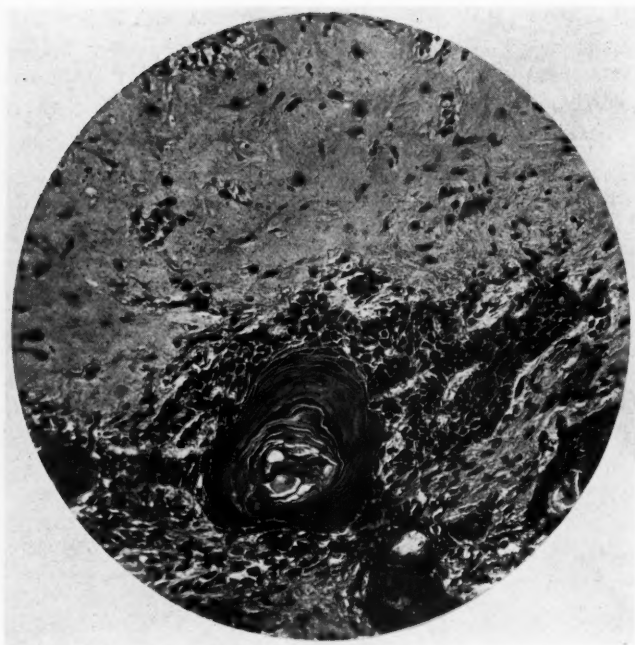


Plate I. Photomicrograph of the mixed tumor showing cartilage and epithelial pearl.

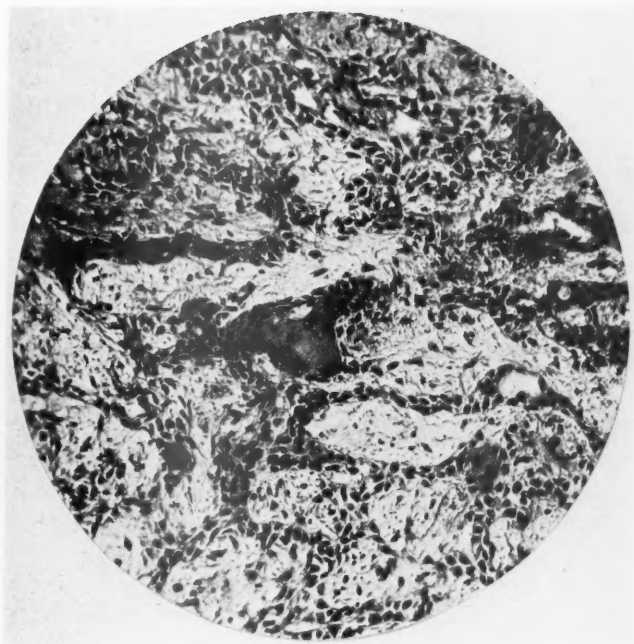


Plate II. Photomicrograph of section of tumor showing stroma with epithelial pearl and strands of epithelium growing throughout it.

The stroma is myxomatous, as a rule, but in many places are strands of a heavier, rather cellular connective tissue. Scattered through the section are rather large irregular islands of cartilage.

Blood vessels are not overabundant and, as a rule, show nothing unusual. There are a few areas that are quite cellular, where proliferation of the endothelial cells is evident. Throughout the section epithelial elements are seen in irregular arrangement. Epithelial pearls are occasionally seen and proliferating squamous cells. Cuboidal cells in glandular arrangement are present with a pink staining material in the center. Finger-like projections of more primitive epithelial cells are usually seen extending from these more formed elements. This miscellaneous epithelium is found scattered throughout the tumor but more thickly seen in the cartilage and heavy connective tissue areas.

The other piece of tissue is composed of cartilage with an area, evidently that to which the tumor was attached, which is bare of perichondrium but surrounded by a thin strip of rather normal looking epithelium.

Microscopically the section shows normal appearing cartilage and epithelium without invasion by the tumor mass.

Postoperative recovery was uneventful.

It is interesting to note that examination of the patient eighteen months after removal of the tumor showed no recurrence of it.

It should be pointed out here that within the area occupied by the tumor is the usual site of Jacobson's or the vomeronasal organ. According to Schaeffer,⁹ the vomeronasal organ is an epithelial lined duct, about 6 mm. in length, occurring on the cartilaginous septum 2 cm. dorsal to the inner margin of the nostril near the nasopalatine foramen. It is quite prominent in early embryonic life, but as development goes on this organ tends to retain its embryonic proportions. It may completely degenerate in early embryonic life, but, on the other hand, is frequently found in adult man. In the sections of the tumor, however, no element could be found that one could identify as Jacobson's organ.

The usually accepted theory as to the origin of mixed tumors is that they have their origin in cell rests which are pinched off during development and which later on begin to grow. The complicated embryologic development of the parotid area, which

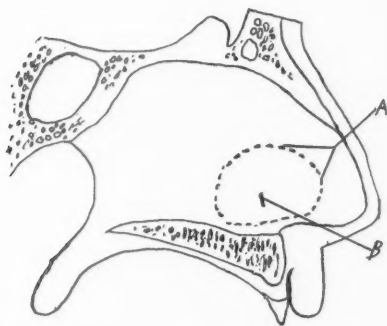


Plate III. Diagram of the nasal septum; (A) Mixed tumor, (B) Usual location of Jacobson's organ.

is the usual location for mixed tumors, gives abundant opportunity for cell rests to occur. The frequency of embryologic remnants, such as branchial cysts, in this region seems likewise to support this theory.

The embryologic development of the nose appears to be as complicated as the parotid area, and it would seem that abundant opportunity is afforded for the formation of cell rests here. In addition to this, there is present in the nasal septum Jacobson's organ which is normally present in the embryo. This should multiply the possibility of forming cell rests here. Growths of embryologic origin are, on the other hand, rare in the nasal septum. In this vicinity this type of occurrence seems to be located primarily in the cutaneous surfaces. Trampnaus¹⁰ has recently reported a dermoid of the dorsum of the nose. Esau¹¹ has reported a dermoid of the bridge of the nose with an extension down into the nasal septum. It should be pointed out here that cysts of the nasal septum formed between plates of cartilage were found by Meeker⁴ in 5 per cent of seventy-five septums examined. These seem, however, to be more on the order of malformations than tumors arising from developmental defects.

If growths of embryologic origin were common in the nasal septum, especially in relation to Jacobson's organ, or if mixed tumors were even occasionally seen here, it might be said that this embryologic remnant had some relationship to the formation

of this type of tumor. This is not the case, however, and it is evident that an isolated instance of a mixed tumor occurring at the site of Jacobson's organ is more by chance than by any predilection for this particular site.

SUMMARY.

A mixed tumor, parotid type, of the nasal septum is reported in a girl, aged 14 years. The tumor with the underlying septum was removed surgically leaving the membranes on the opposite side. After eighteen months there is no recurrence.

Within the area of the tumor is the site of Jacobson's or the vomeronasal organ. No relationship between this embryonic remnant and the origin of this tumor is demonstrable.

421 HUGENOT ST.

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XLVI.

THE TREATMENT OF AUTOMOBILE ACCIDENT CASES WHERE THE NOSE AND FACE ARE INVOLVED.

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NEW YORK.

Automobile accidents, because of the nature of the vehicle, the speed at which it often travels and its usual isolated environment at the time of the disaster, often present characteristics of their own and have, in a way, created a distinct branch of surgery.

Most accidents result in a sudden stoppage in the speed of the car, with the result, if it was moving rapidly, that the occupants are thrown forward so quickly that there is not even time for such reflex actions as that of throwing up the hands for protection of the face. Most injuries result from sudden, violent contact with the windshield. The nose being more prominently exposed to injury than any other part, is usually the greatest sufferer. If the damage is due to the impact, it may vary from a slight contusion to complete maceration of the entire nasal structure. If the injury is from broken glass, its severity may range from slight cuts about the face and nose to complete amputation of the latter, as has happened in the case of several of the patients that have been referred to me.

The prognosis, in many of these accidents in which the nose and face are mutilated, depends to a large extent upon the environment at the time of the accident and the time which must elapse before the services of one sufficiently skilled in this field of surgery can be secured. This is particularly true when the nose has been amputated, for it has been amply demonstrated that even though it has been completely severed from the body it may re-establish vascular connections and become reunited with the stump, provided that it is properly placed in position immediately after the accident. This remarkable recuperative power which characterizes the nasal tissues and which is due to

its vascularity, was dramatically demonstrated in India, where, it is said, the punishment for certain crimes at one time consisted in amputation of the nose of the culprit. It was discovered that in some instances the victim had replaced his severed nose and that it had become reunited with the stump; thus he had escaped the intended punishment. On this account the law had to be changed so as to include the complete destruction of the severed part.

In amputation cases, in addition to prompt replacement, it is equally important for the several tissues of which the nose is composed to be brought into accurate apposition and sutured. It is also important for the part to be kept continuously at bodily temperature; this can best be accomplished by means of my nasal hot-water jacket.

To illustrate the importance of the above precautions and to call attention to the unfortunate results that may follow when they are not observed, I may mention a case that recently came under my care. A woman, forty-five years of age, while motoring in the South, was injured in the following manner: In order to avoid a collision with another car approaching from the opposite direction, she drove her own machine onto the soft shoulder of the road. The car was upset and a piece of glass from the broken windshield amputated her nose by a clean cut reaching from the lower ends of the nasal bones diagonally through the septum and the alar cartilages down to their attachment to the upper lip. The nose flapped down over her mouth but remained attached to the face by two thin bands of skin at the points where the extremities of the alæ join the upper lip. The nose was replaced by her companion and held in place by a handkerchief tied about her head and face. The woman was rushed to the nearest hospital, where she was operated upon, about two hours after the accident, by a surgeon who apparently was not familiar with rhinologic technic. The skin over the dorsum of the nose was brought together and the external appearance of the nose was fairly good. Apparently, however, no attempt whatever was made to adjust the underlying structures and the intranasal tissues, i. e., the cartilage of the septum and alæ and the cut edges of the mucous membrane.

The patient was referred to me two months after the accident by a rhinologist to whom she had gone for relief when she found that she could not breathe through her nose.

There was a perforation in the septum and the alar cartilages, with their covering of mucous membrane, had curled up in such a manner as to completely block both nasal passages.

In correcting this condition I had to separate the mucous membrane from the alar cartilages, resect a part of the latter and re-line the nasal cavities with the flaps thus secured. All of this work was done from within the nose.

The most serious difficulty encountered during the operation was in dealing with the large amount of scar tissue that had formed, owing to the fact that at the time of the original operation only the skin over the nose had been approximated. The mal-adjustment of the other tissues, i. e., the mucous membrane and the cartilages of the septum and alæ, had resulted in healing by granulation and the consequent production of a superabundance of connective tissue, which increases difficulties in any operative procedure.

I have referred to this case somewhat in detail because it illustrates the disadvantages so frequently attendant upon automobile accidents that occur on the road, far removed from all possibility of receiving the special attention so badly needed at the time of the injury.

Frequently neither the patient nor the surgeon who first sees the case appreciates the fact that emergency treatment should be considered as such and as only a temporary expedient, to be subjected to possible revision as soon as possible after the accident, unless he himself is familiar with the operative technic.

In automobile accidents, fracture of the nose is extremely common and it is apt to be severe. The entire nasal arch may be comminuted. These fractures are always compound into the nose and the soft tissues may be lacerated. Such an injury, unless properly treated soon after the accident, is certain to be followed by dysfunction and deformity.

Owing to the extreme vascularity of the tissues of the nose, it is astonishing how quickly they will become fixed in a false position after a crushing injury. Bony union in this locality

occurs, as a rule, within a fortnight. Conversely, how satisfactorily a badly lacerated nose can be reconstructed and an excellent result secured if the patient is seen in time and proper treatment administered. It is a matter of not permitting the fractured parts to unite in a false position.

In the treatment of these fractures, one should bear in mind the dynamics involved in the development of the flattened nose of the infant into the more prominent organ of the adult. In setting the fracture he should strive to duplicate these forces and apply them along the lines pointed out by Nature. I have tried to do this by means of a bridge splint, which I devised a number of years ago, and have found that it meets the exacting requirements of these difficult cases.

Briefly, what the bridge splint accomplishes is:

1. It raises the dorsum of the nose to its normal position and at the same time brings into proper alignment the broken fragments of the nasal arch. This is done by means of two sutures which are fastened to intranasal splints. The sutures are passed through the dorsum of the nose at a point just below the ends of the nasal bones. After the bridge is adjusted, these sutures are fastened to it. The nose is thus held suspended until union of the fragments occurs.

2. The base of the nasal arch is supported by the wings of the bridge, which are adjusted by means of the thumbscrew.

3. This method of treating nasal fractures in children is not satisfactory, for the instrument cannot be kept in proper position for the required time, which is about ten days.

In the treatment of severe injuries to the nose, one should be ever mindful of the possibility of fracture of the base of the skull, especially in the region of the cribriform plate. The force which caused the accident can never be accurately gauged by the examining surgeon, so he must be cautious; he must take advantage of all recognized diagnostic aids before launching into the treatment of the case.

Examination of the eyes and ears and the X-ray examination may throw valuable light upon the situation.

One should be extremely cautious in cleansing the nasal cavities. Neither the spray nor any other method that might increase

the intranasal pressure should be used, lest infection should be carried to the meninges through some unsuspected crack in the floor of the anterior fossa. I have, on several occasions, noted the escape of cerebrospinal fluid from the nose. It is my belief that in these instances, had I tried to cleanse the nasal cavities by any method whatsoever, I would have endangered the lives of these patients. Nature has a way of dealing with this situation that is better than ours. It should be a case of "*noli me tangere*" until at least five days after the cerebrospinal fluid has ceased to flow from the nose before attempting to do anything towards restoring either the function or the contour of the organ. There are, I believe, some exceptions to this rule, for in some instances this fluid continues to escape intermittently for weeks or even months after the accident; here we are warranted in assuming that Nature has established a bulwark against meningeal infection.

In some of these accidents the dust and grime of the road is ground into the deeper layers of the lacerated skin; this, if permitted to remain, will cause unsightly tattoo marks that never disappear.

When the tissues are lacerated it is very difficult indeed to remove this foreign material; one may not discover, until it is too late, that it has not been thoroughly eradicated.

In the treatment of these cases it is sometimes necessary to excise some of the lacerated tissue, if it cannot be cleansed, for it is better to resort to skin grafting than to leave the patient disfigured by an unsightly tattoo mark.

2 EAST FIFTY-FOURTH ST.

XLVII.

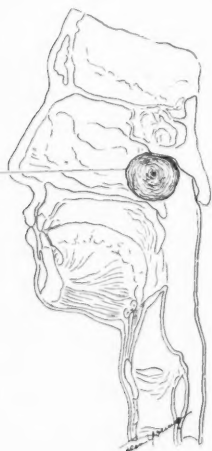
A METHOD FOR THE CONTROL OF POSTNASAL
HEMORRHAGE.

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The technic and apparatus used in the Department of Otolaryngology, University of Michigan, is described as follows:

A Morrison frame is attached to the patient's bed in the usual manner. A firm dry gauze postnasal tampon is prepared and



around its middle a piece of woven silk like that used in maxillofacial surgery is snugly tied. A well lubricated medium sized urethral catheter is passed through the left common meatus of the nose down into the nasopharynx and out through the mouth. The free end of the woven silk carrying the tampon is tied to the end of the catheter protruding from the mouth, and by retraction of the catheter the postnasal tampon is pulled firmly back into the nasopharynx, with the free end of the silk emerging from the left nares. Another piece of silk is tied to the strand coming out of the nose and led over a pulley fixed to the frame of the bed. Light weights are attached

to the silk line to produce a constant tension upon the pack in the nasopharynx. The pull upon the tampon can be readily adjusted by changing the weights. (See illustration.)

By this method constant firm pressure sufficient to control hemorrhage can usually be maintained within the postnasal space, though the patient is free to move the head in all directions. It likewise obviates the necessity of anchoring the silk line carrying the tampon to some part of the head, a procedure which is often painful through injury to the ala or upper lip.



XLVIII.

OTOMYCOSIS: A CLINICAL CONSIDERATION.

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COLUMBIA, S. C.

There can be no doubt that during the past few years diseased conditions due to fungus infections have increased considerably in frequency, or the diseased conditions themselves have become better recognized or diagnosed. The place of fungi in modern medicine is one which should interest any physician except possibly the obstetrician and gynecologist. Some form or variety of fungi has been found in nearly every part of the human anatomy, but, generally speaking, fungi have a predilection for the same kind of body tissues as does the tubercle bacillus. They are very rarely found in the heart or skeletal muscles. On the other hand, they are found commonly on the skin, in the lungs, bones, and occasionally in the spleen, liver, kidneys, brain, eye, ear.

It is the last mentioned location that I wish to call to your attention. Most cases of fungus infection of the ear or otomycosis are in reality skin infections or dermatophytoses, inasmuch as the condition is usually confined to the skin of the external auditory canal and rarely extends to the middle ear, mastoid, eustachian tube or internal ear.

Otomycosis is a subject about which most of the textbooks on otology and diseases of the ear give little or no information. In the seven texts on otology to which I have access the subject is treated as a very rare disease, and the description of the disease varies in most of the books. Various remedies were mentioned under treatment, such as boric acid, hydrogen peroxide, bichloride of mercury. In only one text was any mention made of salicylic acid, and in none of the texts were the iodides named as being used in the treatment of this disease. The incidence of otomycosis

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has been variously estimated by different writers, but it is usually stated that an active, busy otologist will see one case in about every 500 ears that are examined. Judging from my own experience, this is a very low estimate, since during the past twelve months I have seen eight cases among private patients, and two clinic cases upon whom I do not have complete records.

The fungus affection which is most commonly found in the ear is the more or less mechanical obstruction by *aspergilli*. This may be *aspergillus niger*, *aspergillus flavus*, *aspergillus nidulans* or *aspergillus fumigatus*. Some cases have been reported in which the *verticillium graphii* have been found. In trying to classify the fungus from one of my cases I have been in communication with Dr. Fred D. Weidman, professor of dermatological research, University of Pennsylvania. The following is a quotation from a recent letter: "No doubt a great many of the saprophytes out in nature can maintain a footing (albeit precarious) in the auditory canal of man and disturb him, even if only from a mechanical obstructive direction. Some writers do not regard this as true pathogenicity, denominating such organisms as pseudopathogens. However, in the strict sense of pathology, they need not necessarily be invasive (penetration of tissue); just so long as they impair in any way the adaptability of the individual to his environment should they be ranked as pathogens. As to the particular white variety that you mention in your letter, almost any member of the pathogenic hyphomycetes of the skin, whether of athlete's foot, or anywhere else, could give the appearance grossly you mention, recalling that mycelium is really a network of fibers just the same as cotton is. I am unaware of the identity of any of those of the ear with those of athlete's foot. There is no reason why the comparatively protected position of the external auditory canal should remain immune to parasitism by the dermatophytes, unless it be by the thick coating of cerumen."

Practically all patients in my series complained not only of a stopped up ear, but also complained of the ear filling up rapidly—that is, within a day or two after having been thoroughly cleaned. There is usually a sense of fullness in the head, slight pain in the affected ear at times, occasionally head noises. In two patients both ears were affected at the same time. Upon examination of

the ear the external auditory canal is seen to be filled with what appears to be wet paper or wet cotton. Sometimes this mass has a yellowish color, and in one case in which the white pulpy mass was streaked throughout with black areas the *aspergillus niger* was identified under the microscope.

This mass in the canal can be removed fairly easily with a warm bicarbonate of soda solution in the ordinary metal ear syringe. The skin is usually thickened, the ear drum usually normal. At times there is a pellicle which fits closely over the drum membrane, obscuring the view, even after a thorough syringing of the ear. In one of my cases the drum was red, inflamed and raw looking, with a perforation in the anteroinferior quadrant. This patient had not complained of any previous ear trouble, and had put no medication of any kind in the ear. In six of the cases there was a history of previous irritation of the auditory canal with the use of medicaments of some kind. In five of the eight private cases the patients had used oil of some kind or glycerin in the ear, previous to the onset of the obstructive symptoms. One of the outstanding features of this group of cases was the rapidity of the growth in the ear. In the several patients upon whom the proper treatment was not begun immediately, in twenty-four or thirty-six hours the growth would be sufficient to entirely occlude the canal.

The microscopic examination of the growths in these cases has been limited to the demonstration of the mycelium in smears which have been cleared with potassium hydroxide solution. Mycology is a subject in which very few bacteriologists or pathologists have had any real training. Fungi are far less important than bacteria, and mycologic technic and classifications are radically different and much more involved than bacterial. Quoting from Dr. Weidman's letter again: "I shall be glad to collaborate with you in covering the point insofar as whether the organism is or is not one of the dermatophytes; further than that is a most laborious piece of determinative work because it takes one out into a veritable maelstrom of plant pathogens that is comparatively unfamiliar to the medical worker."

In order to determine any possible relationship between otomycosis and fungus disease in other parts of the body all patients

were questioned about skin diseases and other complaints which might have a mycologic basis. Two men stated that they had "itching between the toes," and one woman said she had been visiting her grandchildren, one of whom had had "thrush."

The diagnosis of fungus affections of the ear is rather self evident, although it has been confused with furunculosis of the ear, chronic suppurative otitis media, impacted cerumen, foreign bodies in the external auditory canal, and some other types of diffuse otitis externa. The characteristic pultaceous mass, resembling wet paper or wet cotton, gives a picture which can hardly be mistaken for anything else. The demonstration of the mycelium in a smear requires no great laboratory technic and is really an office procedure.

The prognosis, in my opinion, depends almost entirely upon the promptness with which the proper treatment is instituted. One of the outstanding contributions of dermatology to modern medicine has been the establishment of the treatment of fungus infections with iodine, salicylic acid and the X-ray. In none of the cases of otomycosis in my series was the invasion of the skin of the canal considered sufficient to warrant the internal or intravenous administration of iodine, although in other types of fungus infection the intravenous employment of large doses of Lugol's solution or of sodium iodide is the treatment par excellence. Nor was it considered necessary to expose any of these cases to the X-ray. In each case, after a thorough mechanical cleansing of the canal, a 3 per cent alcoholic solution of salicylic acid was prescribed, to be used once or twice a day, depending upon the amount of pain and reaction produced. This comparatively strong solution of salicylic acid produces considerable exfoliation of the epidermis. This is considered to be desirable, inasmuch as the fungi are thought to grow in the dead skin, and the superficial layer of live skin under anaerobic conditions. If the patient does not complain too much of pain and burning, the instillation of these drops should be continued for three or four days; then the dead and exfoliated skin carefully removed with a cotton tipped applicator. After a few days' rest the salicylic acid should be repeated as before. Usually two courses of treatment are sufficient to destroy the fungi, but it is recommended that the patient use this solution in

the ear twice each week for several weeks in order to insure the destruction of all spores.

The conclusions to be drawn from personal experience and from a review of the literature are that:

1. Otomycosis occurs much more frequently than the textbooks would have one believe.
2. It occurs chiefly in ears in which the temperature and moisture balance have been disturbed.
3. The symptoms are largely due to mechanical obstruction of the canal.
4. The clinical diagnosis is not difficult and is easily verified by the microscope.
5. Treatment with an alcoholic solution of salicylic acid is most satisfactory and is usually the only therapeutic measure necessary for the cure of this disease.

NOTE.—After the cases were tabulated and analyzed with reference to age, sex, ear affected, history of previous diseases, accompanying diseases, present symptoms, etc., there was so little added information brought out that it was decided not to report each case in detail.

The references as appended to this paper have been read mostly in the abstract. They were obtained by special request from the research library of the American College of Surgeons. References to all standard textbooks on otology have been omitted, although seven have been consulted.

MEDICAL BLDG.

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Clinical Notes.

XLIX.

SINUS THROMBOSIS WITH UNUSUAL COMPLICATIONS.

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NEW YORK.

Case 1.—I desire to present this case because it shows a number of unusual features. It has been our experience that the majority of patients having developed such a complication as sinus thrombosis usually show more or less definite symptoms. Among these may be mentioned intermittent fever, chills, moderately high blood count with marked increase in the polynuclear cells and a positive blood culture. Moreover, such symptoms arise when the sinus plate is thin or eroded and when there are evidences of a perisinus abscess at the time of the original mastoid operation. It has been most unusual for us to obtain evidence of a blood infection as late as five to six weeks after the original operation and to have a train of symptoms and complications occur as they did in the following interesting case:

Mrs. L., aged 28, consulted me on March 27, 1930, with the following history: She had had a discharge of pus from her left ear on and off since childhood. Two months before consultation she had an earache with spontaneous rupture of drum and discharge. The pain ceased but the ear continued to discharge profusely. Hearing was diminished in the left ear and she complained of indefinite head noises. Local examination of the ear showed a profuse discharge of mucopus. There was no evidence of acute inflammation or of mastoiditis. There was some congestion of the eustachian tube on the left side. Observation during the next week or two showed no subsidence of the discharge. X-ray picture gave clear evidence of a broken down mastoid and therefore operation was insisted upon.

Mrs. L. was admitted to the Park West Hospital on April 11, 1930. She had no temperature. A simple mastoidectomy was performed that same afternoon. The mastoid cavity was found filled with pus and broken down bone. Neither dura nor sinus was exposed. In fact, the dural plate and sinus plate were unusually hard. The wound was closed except at the lower angle and a small drain inserted into the wound and antrum. The recovery from the operation was unusually rapid and the patient left the hospital on the ninth day, not having had any temperature and with a wound that was entirely healed.

For the next eight or ten days she was in excellent condition. She then began to complain of not feeling very well, having attacks of dizziness and general restlessness. She was readmitted to the hospital on May 1st with a temperature of 100.8. Five days later she was taken to the operating room, where the mastoid wound was reopened and a thorough investigation made of the operative area. Although granulations were present in the cavity there was no pus and the sinus and dural plates were hard and intact.

It would be impossible to go into all the details of what followed, so we shall enumerate them more or less in chronologic order to give one an idea of what transpired.

The first thing that puzzled us was that, although she ran an intermittent temperature, between 99 and 105.8, the blood count was disproportionate to the temperature. Her first blood count showed 5,500 leucocytes to the cubic millimeter with 79 per cent of polynuclears. Repeated blood counts were taken from that first date, ranging from 3,600 leucocytes to a maximum of 10,800, and the polynuclears ranging from 69 to 77 per cent. A few days after reopening the mastoid wound her condition was so serious that it was a question of some intracranial condition, so a spinal puncture was done, which proved to be negative. Because of the low blood count and the possibility that the condition of the patient was not due to her ear condition every conceivable test was made, particularly to discover whether she had a possible typhoid fever or malaria. At one time her Diazzo reaction was positive, but the Widal reaction was negative and no typhoid, paratyphoid or bacillus dysentericus could be discovered.

in the stools. Blood cultures were taken on May 6th and at later dates. All of the blood cultures were negative until May 25th, a period of six weeks after the original operation, when a very few colonies of streptococcus hemolyticus were found on one plate and in the broth culture.

On May 7th, two days after the second operation, Dr. William R. Williams was called in consultation. He found tenderness in the right costovertebral region and the urine gave a suggestion of pyelitis which was later ruled out. Examination of the eyes on the following day by Dr. Vandegrift was negative. On May 9th, Dr. Harlow Brooks was called in consultation. He stated that moist râles were found at the base of both lungs. There was tenderness over the spleen, which was palpable, and he felt that typhoid or paratyphoid could not be eliminated. Because of a lowering of the hemoglobin a blood transfusion was given to the patient on the 12th of May (250 cc.) and again on the 19th of May (100 cc.). Subsequently the patient received four more transfusions in amounts ranging from 500 cc. to 750 cc., the donor in every instance being the husband.

Not being satisfied with her condition, we felt it necessary to receive the opinion of another ear specialist, and Dr. I. Friesner was called in consultation. He suggested that there was a possible sinus thrombosis; but in view of the fact that there had been no chills, that the sinus plate had been hard and intact, that the blood culture was negative and that the symptoms had appeared at such a late date after the original operation, he advised observation and agreed with us that no operation should be performed at that time. A blood culture, taken on May 24th, was the first one to show any bacteria, and the following day the patient was taken to the operating room. The original wound was again reopened. We found a hard sinus plate which had to be chiseled away. The vein had an almost natural bluish tint and pulsation could be felt. As the patient's condition was rather poor, local anesthesia was employed. Deciding that the wise procedure would be to ligate the jugular vein, the sigmoid sinus was not opened but the jugular vein was exposed and ligated under local anesthesia. Before the upper ligature was applied, about two ounces of blood were allowed to flow from the vein, thus emptying out

any blood contained in the sigmoid sinus above, according to a successful procedure outlined by me in former cases.

The patient left the operating room in good condition, but the temperature did not subside. Blood cultures taken after the operation were negative and remained negative. However, we were not satisfied with the patient's condition and felt that possibly metastatic foci would appear elsewhere. On June 3rd, the patient complained of pain over the right shoulder blade. Dr. Harlow Brooks was again called in consultation. It was suggested that possibly an abscess of the scapula was forming. Meanwhile I felt that it was advisable to open the sigmoid sinus, which was done under local anesthesia early on the morning of May 30th. No clot was formed, but a localized abscess of the vein was evacuated, which had no influence on the subsequent course of events.

On June 6th, the patient was seen by Dr. Charles Goodman, who found a diffuse swelling and tenderness over the right scapula, extending below the inferior angle. X-ray examination indicated a localized abscess. On June 13th, this abscess was opened by Dr. Goodman. On June 19th, the patient was seen in consultation with Dr. Mosenthal. The abscess of the right scapula was evident. He felt that an empyema of the right chest was forming. He also felt that there were symptoms of an acute diffuse granular nephritis. On June 19th, Dr. Goodman and Dr. Gordon aspirated the right chest, obtaining 1,000 cc. of turbid fluid. As the patient still seemed to continue with serious symptoms and the condition in the chest began to localize itself, a thoracotomy was performed by Dr. Goodman on July 2nd. No pus was obtained but tubes and packing were inserted. The patient still continued to run high septic temperatures, with no abatement of any of the symptoms. The mastoid and neck wounds had entirely healed. Feeling that the condition was mainly due to the trouble in the chest, Dr. Goodman resected the eighth and ninth ribs on July 31st. No pus was obtained at that time but later on considerable pus came out of the drainage tubes. From that time on the patient seemed to be getting better, but the temperature still continued and it was a question as to whether an abscess of the liver was developing, the liver being considerably enlarged and palpable. Aspiration of the liver in numerous places

did not bring forth any pus. On August 28th, Dr. Alexander Lambert was consulted. He found a pus pocket extending toward the vertebral column near the posterior chest wound. He felt that a pneumothorax had developed which was not connected with the wounds opening externally. However, nothing more of an operative nature was done, and from that time on the patient's symptoms began to subside, the temperature went down to normal where it remained for quite a few days. Again, about September 15th, the temperature began to rise to 102. The drainage tubes had been removed but had to be reinserted again.

Analysis of Case.—A review of this case brings out a number of unusual points. Even with the co-operation of a number of eminent consultants and in the hands of an otologist and competent physician, it was impossible at any time to arrive at any definite conclusion (a) whether a vein infection was present or not; (b) the reason for the continued temperature after the jugular vein was ligated and the sigmoid sinus cleaned out. If the patient had been devitalized, one might have expected a low blood count, but a blood count of 3,600 in a healthy individual is most unusual. We have stated that the bony plate over the sinus was unusually hard and that no organisms appeared in the blood in spite of repeated cultures, often taken at the height of the temperature, until six weeks after the original operation. As a rule, the sinus plate is thin, eroded or a perisinus abscess is present.

We feel that the ultimate recovery of this patient has depended, to a great extent, upon the careful nursing she received and the unusual pluck of the patient. A continued infection, even when the original sources are discovered and attended to, frequently results in such depletion of the patient that nothing will bring about a recovery.

The salient points in this case are:

1. Low blood count with normal polynuclear count.
2. Negative blood cultures until six weeks after the original operation and then only two colonies appeared on one plate.
3. The conflict in diagnoses made by prominent consultants.
4. The great number of transfusions necessary.

5. The appearance of a deep-seated abscess under the scapula as the first sign of a metastatic abscess, and finally, the unusual resistance of the patient.

Case 2.—Mr. A. B., 51 years of age, consulted me early in June, 1930. History: Profuse discharge of pus from right ear for six weeks. The onset of the trouble had been sudden with spontaneous rupture of drum and later one or two incisions for better drainage. Although no headaches, feeling of discomfort in right side of head and tinnitus. Restless, particularly at night, loss of appetite. No tenderness over mastoid. No temperature.

Examination showed a large, well nourished man. Very nervous and worried. Nasal examination showed evidence of hyperplastic ethmoiditis. Throat examination negative. Left ear normal. Right ear canal slightly narrowed. Profuse discharge of tenacious pus. Drum thickened and inflamed. Sagging, particularly of posterior superior wall. No tenderness over mastoid. X-ray picture of mastoids showed cloudiness of all cells on right side with some breaking down.

Patient was admitted to the Park West Hospital the following day. No temperature. Blood count normal. Culture of pus from ear showed streptococcus hemolyticus. A simple mastoidectomy was performed the same afternoon. The mastoid structure was broken down. The sinus and dural plates were hard and intact. The wound was closed except at lower angle, into which drain was inserted, extending into the antrum.

The patient made an unusually rapid recovery. He insisted on getting out of bed the day following the operation. At the end of ten days he left the hospital with a wound which was practically healed and came to the office for further dressings.

Although the patient looked unusually well, he continued to complain of spasmodic pains in his head on the right side. The middle ear looked normal; the hearing was good. Fearing there might be some retention in the wound, a portion of it was reopened but nothing was found. After trying one remedy after another, he was readmitted to the hospital and kept under observation for four days. During this time the temperature was normal, blood counts within normal limits and every symptom

disappeared. But he was no sooner returned to his home than his distress was so great that I suspected some intracranial complication.

On August 8th, over six weeks after his original operation, he again entered the Park West Hospital. Temperature was 103.4. For the first time there was a boggy, edematous swelling in the upper portion of the mastoid wound. A localized abscess had formed, which was immediately opened under ethyl chloride general anesthesia. A small packing was inserted into the wound. I thought that would be the end of our troubles as the pain in his head subsided.

The patient's temperature went to normal the following day and remained low for two days, when it again jumped to 103.4, again remained normal for three days, then became irregularly intermittent for a few days longer. Blood count on admission showed 13,100 white cells, 83 per cent polynuclears, hemoglobin 75 per cent. Wassermann negative. Blood culture was sterile after forty-eight hours' incubation.

Because the symptoms were so localized and there was no evidence of a sigmoid sinus infection, Dr. Ira Cohen, a neurologic surgeon, was called in consultation on August 11th. A most thorough examination revealed no intracranial condition. A second blood culture, taken August 14th, was sterile after thirty hours. Later the glucose broth flasks showed a positive growth of streptococcus hemolyticus. A blood count, taken August 14th, showed an increase of white blood cells to 16,000 with 85 per cent polynuclears.

On the strength of the positive blood culture, the rise in temperature and the return of the pains in the head, I decided to explore the sinus and ligate the jugular vein if necessary. The patient was operated upon on August 16th. The plate over the sinus, as in the previous case, was so dense and hard that it was necessary to chisel through it. The vein was of good color and distinctly pulsating so it was not opened. The jugular vein was exposed in the upper triangle of the neck. Before the upper ligation was tied, about two ounces of blood were allowed to flow out in order to clear out the vein from above. The operative procedure was then as usual.

A blood culture, taken August 18th, still showed one or two colonies per plate. The blood count on August 22nd was as follows: White blood cells, 15,000; polynuclear cells, 82 per cent; hemoglobin, 65 per cent. Urine negative. Blood chemistry negative. Later blood cultures remained negative, but the percentage of polymorphonuclear cells remained high.

Because of the persistent continued temperature, ranging from 99.6 to 103, the high blood count, the reduction in hemoglobin and the presence of a few bacteria in the blood, a transfusion of 750 cc. of blood was given by Dr. Unger on August 25th. The temperatures still persisted and so, four days later, the sigmoid sinus was opened up but found to be perfectly clean.

Shortly before the transfusion, on August 22nd, the patient began to complain of pain in his left hip. An X-ray picture showed evidence of a fractured portion of the lip of the lesser trochanter. It could not be determined whether this was a recent injury or not. I felt that the patient may have turned his leg suddenly when getting out of bed, but the pain persisted. On August 25th, he was seen in consultation with Dr. James McAteer, who felt that there was a possible synovitis of the hip joint and ordered rest and traction.

From this time on, until September 26th, when the patient was taken out of my hands, he became decidedly worse; the irregular, intermittent temperature, ranging from 99 to 104.6, continued until he left the hospital. The pain in his hip and leg still persisted and definite swelling of the thigh and leg appeared. On September 5th, he was seen by Dr. Victor Meltzer, who reported an elongated sensitive swelling, painful to pressure, in the left inguinal region which he suspected was due to a thrombosis of the iliac veins.

The swelling continued to advance until there was definite edema of the scrotum and extension of the edema above Poupart's ligament on to the abdomen. In spite of rest and heat applications the patient's condition became most distressing. An X-ray of the hip, taken September 6th which indicated a synovitis, showed nothing else of importance. On September 15th, Dr. John Erdman was called in consultation. He advised complete rest of the leg and observation.

On September 24th, Dr. William R. Williams examined the patient and reported as follows: The edema extends up the back to the level of the lower ribs on the left side, across the buttocks and down the back of the right thigh and to the scrotum. This is caused by a thrombophlebitis of the iliac veins. An abscess has formed around an upper right molar tooth and the condition of the other teeth is questionable. He advises attention to the teeth and repeated small transfusions.

On September 26th, the upper right third molar and second bicuspid were removed by Dr. Ed Whyman. A broken down, infected abscess sac (possible cyst) was found and the diseased process had burrowed through the bone and into the soft tissues of the cheek. Other teeth, which seemed diseased, were also removed. Culture taken from the infected area showed streptococcus hemolyticus.

The patient left the hospital, with temperature of 102, against my advice, on September 26th. I am informed that he died from his infective thrombophlebitis a few weeks later.

CONCLUSIONS.

1. Even when a simple mastoid operation is performed, with no exposure of the sinus, an infection of the vein can take place.
2. When the original wound is healed, even as late as six weeks after operation, a blood culture may show a few organisms.
3. One must seriously take into account indefinite symptoms which may eventually result disastrously.
4. In such cases, where evidence of vein infection comes some weeks after operation, complications are even more severe than in the ordinary cases of thrombosis.
5. Attention to the vein at this late date does not always ward off complications.
6. Finally, transfusions may assist and eliminate bacteria from the blood but do not ward off sequelæ.

64 EAST 58TH STREET.

L.

TWO CASES OF SURGICAL MASTOIDITIS WITH UNUSUAL COMPLICATIONS, INCLUDING REPEATED RUPTURE OF THE LATERAL SINUS: RECOVERY.

VIRGINIUS DABNEY, M. D.,

WASHINGTON.

Case 1.—A. C. After a two-day cold in the head this ten-year-old girl complained of an earache and showed a fever of 101. The drum was incised by the family doctor, who ordered hot irrigations and instillation of mercurochrome solution. During the first three days the discharge gradually diminished and the temperature fell to 99, but on the fourth day the temperature rose suddenly from normal to 103 with a great increase in the discharge. It was at this stage that I first saw the case, a girl, some twenty pounds overweight (subsequently found due to marked hypothyroidism), intensely apprehensive and evidently very toxic. She had a dry, irritative cough and pus in copious amount was flowing apparently from her left antrum down the posterior nares and pharyngeal wall. The stain of the mercurochrome rendered the landmarks of the canal and drum obscure, but the pronounced bulging of the latter, the profuse discharge and the history rendered the prognosis of surgical mastoiditis easy to make. The mastoid tip was the only sensitive point on the process, and this was the only place where pus was found at operation, twelve hours later, the rest of the process being packed with flabby granulations and much bloody serum (hemolytic streptococcus). The sinus plate was destroyed by disease in its entirety, the membranous sinus lying in the bottom of the wound like a large worm, but free of granulations or any apparently necrotic spots. Six days later, however, at the third dressing, an area that must have necrosed adhered to the packing and tore, causing a profuse hemorrhage. As the wound was bathed with bloody serum swarming with the hemolytic streptococcus in pure culture it was thought the part of wisdom to ligate the internal jugular vein the same

day. This was done without incident in twenty minutes. Two days later a slight erythema appeared in front of the tragus and, as the temperature rose to 105, the tentative diagnosis of erysipelas was made and antitoxin given immediately with almost spectacular results, the temperature falling in six hours to 100 and rising in another twelve only to 101, when a second dose was given as a precautionary measure, the erythema never spreading beyond the malar bone or the hair edge of the temporal fossa. The characteristic desquamation began in two days and lasted for a week. Her cough was so persistent that we had a roentgenogram of the chest done, and it showed a double lobar pneumonia, which we estimated had existed from the third or fourth day after operation. This cough was so violent that the silk stitches in the neck were torn loose and the intracranial pressure so great against the weakly healed sinus wall that three times it ruptured during a coughing seizure and bled through the bandage. To offset this and as a fortifying measure, a blood transfusion was done after the first hemorrhage, the temperature falling from 103 to 95.2, only to climb back in three days to 103 again. For the next ten days it ran irregularly from 101 to normal (septicemia), when she was taken home on a stretcher, and the wound healed in three months. Despite the double pneumonia the leucocytes never were higher than 20,000 or the polymorphonuclear cells more than 86 per cent, though the hemoglobin did fall to 64 per cent. The blood cultures were always negative. Thus this apparently poorly resistant type of child was able to overcome this formidable array of diseases: surgical mastoiditis due to the serious hemolytic streptococcus, double lobar pneumonia, internal jugular and lateral sinus phlebitis, erysipelas, septicemia and a probable acute empyema of the antrum of Highmore, all superimposed on a marked hypothyroidism, which is still under treatment.

Case 2.—F. K. The right ear drum of this six-year-old girl was opened by the attending physician and the case cared for by him for three days, during which time the temperature clung to 101 in the afternoon and fell only a fraction in the morning. Her continuous pain and profuse discharge led to my being called to see her on the fourth day, when I found the drum bulging, the pus forming as fast as it was wiped away from the perforation.

the hearing on that side almost gone and the entire process sensitive to the lightest touch. Operation was refused till the next morning (eighteen hours), when complete disintegration of the cellular structure was found and the resulting cavity full of bloody serum (hemolytic streptococcus). The fever varied from 100 to 101 for six days, but she never looked well to me, having a drawn, apprehensive look in her face that always bodes ill in a surgical case. In apparent justification of my fears, on the morning of the seventh day the fever fell suddenly without chill to 99, rising that night to 105, and again falling the next morning to 99.5. I immediately ligated the internal jugular vein and explored the lateral sinus. The vein was the color and consistency of boiled macaroni and densely adherent to the sheath (phlebitis), while the sinus was so sclerotic that I thought my scalpel was dull and called for another. On getting through, the wall was found very thick and a well formed mural clot adherent in the entire circumference. Bleeding from the torcular end was easily obtained, but not, of course, from the bulb end at all. Evidently the phlebitis of both vein and sinus had existed for fully a week, possibly accounting for the toxic appearance of the child which puzzled me. A stubborn cough and a fever that ran as high as 101 at night, together with my experience with the other case still in the same hospital and at this very time struggling with pneumonia, led me to have the chest X-rayed, disclosing a slight pneumonic area in the left hilus, though the temperature was not the usual sustained type of this disease. In fact, the second day thereafter it suddenly rose to 106.2 (rectal) with a chill and fell in twelve hours to 96.4 (rectal), without any resolution in the lung. The constant headache and the mental confusion of the child led me to do a lumbar puncture, which happily showed nothing abnormal, but a transfusion was done the next day. Three hours later the temperature was 105.4 (rectal), which I feel was due either to a meningeal irritation or a localized meningitis. For the next three days the temperature ran from 98 to 103 (meningeal?), and for ten days thereafter from 99 to 102 (septicemia). After this it gradually subsided to normal, which was reached in three weeks, and the child was discharged from the hospital. The wound healed in two and a half months. Two weeks after the ligation the

double silk ligature appeared at the lower angle of the neck wound, something I have seen happen three times in my own practice and once in consultation with a colleague. The particular peculiarity of this case, aside from the serious complications, was the extreme range of temperature, frequently as much as 8 degrees in twenty-four hours and once 9.4 degrees (106.2 to 96.4, rectal temp.). The entire pathologic picture included: surgical mastoiditis, lateral sinus and jugular thrombosis, probably localized meningitis, septicemia and pneumonia.

Points of interest in these cases:

1. Apparently confirmatory evidence of the generally recognized characteristic of the hemolytic streptococcus (a) in overwhelming the resources of the body to the extent of preventing a high and hence protective leucocytosis, even in the presence of a pneumonia, where a high white cell count is nearly always found; (b) relatively low temperatures, a high temperature being conservative and protective in the presence of infection; (c) destruction of red cells (first case, 60 per cent; second case, 55 per cent).

2. Remarkable resistance of children to grave infection and complications.

1633 CONNECTICUT AVENUE.

LI.

TRAUMATIC PNEUCEPHALON.*

RICHMOND MCKINNEY, M. D.,

MEMPHIS.

Jim Tatum, negro, male, aged 34 years, was referred to me in February, 1931, with the following history:

November 18, 1930, falling from a runway into an oil mill where he was working, he was evidently struck on the head, for, three days later he awoke to find himself in a hospital. There was an injury on the right side of the head, just above the nose. He was in the hospital for six days, and from that time on had a pain in the top of his head. When he would lean over, clear water would run out of the right side of his nose, and sometimes, when walking along, his head would feel very heavy, and water would run out and bring some relief.

The shape of the head was of the dolichocephalic type, not uncommon in the negro race. There was a puckered scar, with slight depression on the right side of the forehead. On leaning forward or bending his head down, when compression was made of the jugular veins, or other methods of raising the intracranial pressure, clear, colorless fluid escaped from the right nostril—as much as an ounce at a time. He complained of severe headaches, especially after blowing his nose or after exertion of any kind. X-ray films of his head showed a large accumulation of air on the surface of the brain, pushing it backward and downward. A defect was seen in the upper part of the right frontal sinus.

A neurologic surgeon was called in consultation, and the consent of the patient was readily secured for an operative procedure designed to bring about relief.

Under local anesthesia, a small transfrontal flap was turned down on the right side. A hole was seen in the upper posterior wall of the frontal sinus. A spicule of bone was sticking through

*Read before the Eastern Section of the American Laryngological, Rhinological and Otological Society, New York City, January 9th, 1932.

the dura near the superior longitudinal sinus, and there was an oval defect in the dura about one by one and one-half centimeters, through which could be seen the thickened, opaque arachnoid, which was not adherent to the dura but fell away from it as air and fluid escaped. It was impossible to close this dural defect and suture the other small wound in the dura after extracting the spicule of bone. As a second line of defense, the defect in the posterior wall of the sinus, which was about two and-one half by three centimeters, was closed by an osteoperiosteal graft released from the flap and fitted into the opening with the periosteal side facing the sinus. The closure was effected in the usual manner by suturing the galea and the skin with interrupted sutures of fine black silk, without drainage.

The headache was relieved completely; there has since been no leakage of fluid from the nose, and the wound healed by first intention, the patient being discharged at the end of a week.

Two months after the operation this man stated that he had had no headache and no leakage of fluid, and felt well.

899 MADISON AVENUE.



Fig. 1. Photograph of patient, showing location of scar.

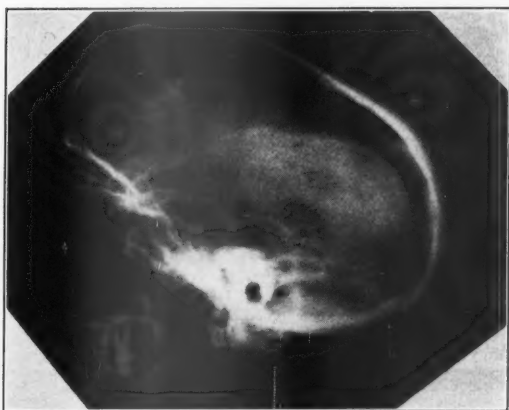


Fig. 2. X-ray picture, showing air on surface of the brain, pushing it backward and downward.

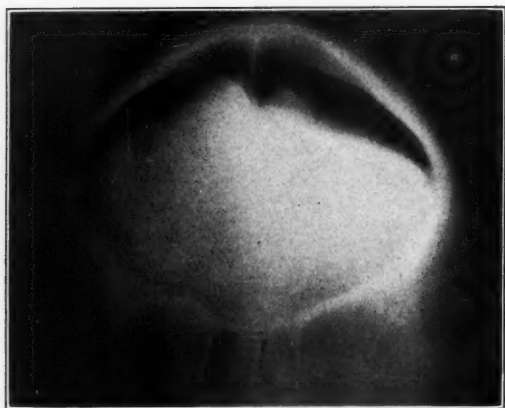


Fig. 3. Another view, showing same effect.



Fig. 4. X-ray picture, showing brain returned to normal position, made several weeks after operation.

LII.

FIVE NASAL TUMORS.

EUGENE R. LEWIS, M. D.,

LOS ANGELES.

SYSTEMIC TREATMENT OF RECURRING FIBROMATOUS POLYP IN THE NASOPHARYNX: CASE REPORT.*

Charlotte S., white, 11½ years old, referred by Dr. Sellers of Dallas on account of postnasal obstruction interfering with intelligibility of speech, respiration, deglutition and sleep. Studied by Drs. Sellers, McReynolds and Goforth of Dallas, January, 1928, to the spring of 1931, when she moved to Los Angeles. At first examination Dr. Sellers had found a mass largely occupying the nasopharynx which on removal ultimately proved to be fibromatous polyp originating in the left middle nasal meatus. This was completely removed again in October of 1928. X-ray and biopsy examination confirmed the diagnosis of nonmalignant fibrosed nasal polyp arising in the region of the left antral ostium. Antral exploration revealed no polyp in the cavity. The growth recurred and was removed in May, 1929, at which time further explorations and X-ray studies failed to discover other masses. During 1930 the growth again recurred, requiring removal, at which time further studies again showed no other neoplasia or pathology. During the course of scarlatina, the winter of 1930-31, double acute otitis media developed which subsided completely with no sequelæ. Recurrence of the mass was detected during the spring of 1931, at which time the family removed to Los Angeles.

I found a pale, poorly nourished girl weighing 51 pounds; normal temperature; fibrotic polyp extending down to base of tongue, almost completely obstructing postnasal respiration, seriously interfering with enunciation, deglutition and rest at night. In view of the history, I proposed systemic measures aimed to

*Presented October 24, 1931, Clinical and Pathological Society of Los Angeles. Later reported January 30, 1932, Western Section A. L., R. and O. Society, Los Angeles.

induce profound alteration of general biochemistry. The case was presented at the October meeting of the Los Angeles Clinical and Pathologic Society. In less than six weeks the mass had completely disappeared, the patient had gained seven pounds and her strength had increased satisfactorily. I then reversed the systemic measures in order to see whether recurrence would take place, which it did, and the case was again shown at the Los Angeles Clinical and Pathologic Society, December meeting.

Under systemic measures calculated to effect the original biochemical changes the mass again disappeared, and examination the last of January, 1932, showed no evidence of trouble, good color, strength and general condition, and weight 61 pounds.

NASOPHARYNGEAL FIBROMA: CASE REPORT.*

In conjunction with two cases of rhinoscleroma, in which disappearance of tumors characteristic of that condition has been marked, I take this opportunity to present one other case of tumor recession under biochemical systemic therapy.

Fernandez, 29 years old, was studied thirty months ago at the Eye, Nose and Throat Department of the Los Angeles General Hospital, at which time diagnosis of infected antrum was made and the Caldwell-Luc operation was done. In November, 1931, Dr. Friesen discovered nasopharyngeal fibroma, and recalling the first case herein reported, referred the case to me. Symptoms included general debility, headache and marked impairment of enunciation. Arising from the posterior superior nasopharyngeal wall and extending forward to the nasal septum the sessile mass extended downward to a level three-quarters of an inch below a line drawn from the upper incisor to the palate at the root of the uvula. Its consistency was woodlike, surface nodular; it bled spontaneously at times. Bulging forward from the nasopharyngeal vault and posterior wall, it completely occupied the nasopharyngeal space. By anterior rhinoscopy along the nasal floor a good view of anterior face of tumor, both sides, but no view of posterior pharyngeal wall was possible.

On examination, January 29, 1931, both posterior nares had unblocked sufficiently to permit resumption of respiration along

*Presented January 30, 1932, Western Section A. L., R. and O. Society, Los Angeles.

the nasal floor; and anterior rhinoscopy on both sides permitted views of the posterior nasopharyngeal wall along the floor of the nose below the tumor, which had hitherto shut off all view of the nasopharynx. The patient had gained ten pounds in weight, headache was gone, enunciation much improved and general strength much better. By the same method of measuring, the lower margin of the tumor had receded 1 inch, and the total mass had diminished to about half its former bulk. The case is presented for examination, comments and suggestions, especially anything bearing upon diagnosis. From present indications, complete disappearance of the tumor is to be expected.

TWO CASES OF RHINOSCLEROMA:*

These two cases were referred to my clinic by the courtesy of rhinologists on service at the Los Angeles General Hospital.

Lopez, 24 years old, Mexican, ten years in United States, seen March 16, 1931. Chief complaints, progressive general debility, increasing impairment of phonation and nasal functions during the past five years. Weight, 118 pounds; blood pressure, 132/62; temperature, A. M. 96 to 97°, P. M., 98 to 98.4°; B. M. R., —22; Wassermann negative; urinalysis negative. Alae naris markedly immobile and tender; nasal floor one-half inch to two-thirds inch higher than normal; mucosa pale, uneven and nodular; much crusting and exquisite tenderness throughout; nasopharynx asymmetrical, palate immobile, nasal and pharyngeal tissues of wooden-like texture. General physical examinations and chest X-rays have revealed nothing significant.

During the previous three years he had been studied at San Pedro Health Center and Los Angeles clinics; suspected of tuberculosis and malignancy; no definite diagnosis. History revealed occasional pruritus, hyperceruminosis, repeatedly negative Wassermanns, habitually low fluid intake and high carbohydrate Mexican diet. Ordered high fluid, fat and protein diet, including fresh fruits and abstention from all possible starches. During absence on account of death in family, diagnosis deferred.

March 20, 1931, hemogram: Erythrocytes normal, 3,800,000; hemoglobin, 76 to 80 per cent (relatively high color index):

*Presented January 30, 1932, Western Section A. L., R. and O. Society, Los Angeles.

leucocytes, 7,400; 65 per cent polys—29 show toxic budding; lymphocytes, 30 per cent—16 show leucocytoïd changes (moderate toxic picture); 5 per cent large mononuclears, 1 per cent eosinophiles. Biopsy reports Mikulicz cells, hyaline bodies, bacillus rhinoscleroma. During the following two weeks further clinical, pathologic and bacterial studies confirmed diagnosis. Systemic iodization provoked marked focal reactions throughout nasal and pharyngeal tissues. Pulse pressures were consistently between .8 and 1.1 on a systolic level of 130. Fourteen-day saturations with chlorides, alternating with shorter saturations with iodides and longer courses of ascending doses of liquor potas. arsenit. were prescribed in conjunction with continued high fluid, protein, fat and low carbohydrate diet, and local applications of heat.

May 14, 1931, hemogram: 7,800 leucocytes, 64 per cent polys, 21 per cent lymphocytes, 9 per cent large mononuclears, 5 per cent transitionals, 1 per cent eosinophiles; 4,570,000 reds, 85 per cent hemoglobin; color index .95. Examined by members of American Board of Otolaryngology (Drs. Beck, Mosher, Mullin, Proetz et al.), who concurred in diagnosis of rhinoscleroma. In the course of the following seven months local and general improvements were progressively noted.

December 12, 1931. Weight, 133 pounds; pulse pressure between .4 and .6 on systolic level averaging 110; commensurate increase in strength and well-being; nasal symptoms and findings were equally improved, and tenderness, tissue rigidity and nodular infiltrations definitely lessened; at work as laborer during the last of December and all of January. Examination, January 30, 1932, at the Western Section American Laryngological, Rhinological and Otological Society: Weight, 135 pounds; nasal symptoms almost gone; mucosa pink, no crusts; nasal floor less thickened and all areas less tender; alæ and palate more mobile; nasopharyngeal walls moist and clean; general strength excellent. Consensus of opinion, "rhinoscleroma": Drs. Graham (San Francisco), Fenton (Portland), Fowler (New York) et al. "Leprosy" was the only other diagnosis suggested—by Dr. Pinkerton (Honolulu), who finally ruled this out after thorough review of history and physical

findings supplemented by microscopic examinations of biopsy specimens.

Chavarria, 29 years old, Mexican, seven years in the United States; seen July 15, 1931. Chief complaints: Gradual loss of weight, progressive weakness and impairment of respiratory functions of nose and glottis, resulting in absolute aphonia for three and one-half years. Weight, 121 pounds; blood pressure 110/50—108/54 on successive days; B. M. R., —29; erythrocytes, 5,180,000; hemoglobin, 98-100 per cent; color index .9+; leucocytes 6,900, polys 45 per cent, lymphocytes 48 per cent—toxic budding, large mononuclears 3 per cent, eosinophiles 4 per cent; slightly toxic picture with basophilia (Dr. Parsons).

Careful study of dietary habits revealed lifelong high carbohydrate Mexican food; for many years total fluids, four to six glasses daily. Marked atresia of both anterior nares; nasal floor approximately three-quarters of an inch above normal level; large perforation of cartilaginous septum (apparently followed nasal operation several years ago); mucosa and all nasal tissues exquisitely tender, fragile, easily bleeding, dry and crusted; intra-nasal inspection very difficult because of atresia and immobility of tissues about the anterior nares, but the floors and lateral nasal walls were found to be nodular and fibrotic; pharyngeal cicatrizations distorting the palatal arch—uvula drawn upwards and forwards, forcibly, out of sight; entire mucosa dry and filmy; view of cords and arytenoids interfered with by fixed epiglottis doubled on itself into midline position; for over three years has had only whisper voice; swallowing was interfered with at times.

Began high fluid intake at once and ordered to omit starches and increase proteins and fats (also stopping arsphenamin therapy which had been administered in another department). Because of the patient's circumstances it was impossible for him to follow the prescribed dietary changes completely. During the first three months he was given successive systemic saturations with nitrochlorides, iodides and arsenites, with little evidence of effect. From then on his weight and general strength slowly improved, nasal discomfort gradually lessened and phonation occurred with increasing frequency. During January, 1932, he was still receiving relatively high carbohydrate provisions from the county in

spite of our repeated attempts to secure the ordered diet. On January 30th, he was examined by those attending the Western Section of the American Laryngological, Rhinological and Otological Society, the consensus of opinion being "rhinoscleroma." The only other diagnosis suggested was "atypical leprosy," by Dr. Pinkerton of Honolulu, who made further extensive physical and microscopic examinations, after which he discarded the idea of leprosy. He was seen at this time by Drs. Fowler (New York), Graham and Fletcher (San Francisco), Fenton (Portland, Ore.) et al.

Symptoms: Local—Discomfort and irritation is first experienced, as edematous nodules form at the anterior nasal floors. These slowly organize into firm fibrosis and show areas of shallow ulceration and healing. As the process progresses more marked tenderness and mucosal fragility develop, with increasing nasal respiratory obstruction and crusting. There are occasional periods of watery discharge, with or without mucoid, purulent, sanguinous or mixed material. Extensions backward along the nasal floor and upward along lateral nasal wall and septum proceed slowly and steadily. These participate in the extensive, fibrosing cicatrizations of subsurface tissues which gradually bring about the characteristic intranasal distortions through contractures and nodular tumor formations. One outstanding feature is the change in level of the nasal floor which comes to lie one-third to two-thirds of an inch higher than its normal level. As time passes, the process extends, involving the palatal, pharyngeal, glottic and other structures with apparently no limit.

General—After weeks or months there seems to be nothing characteristic. The patient begins to realize that local symptoms and signs are accompanied by gradually impaired appetite, weight and general strength. Disturbance of sleep by local nasal symptoms may add to his gradual debilitation. One finds subnormal morning temperature and tendencies to lower respiratory troubles, but little or nothing definite.

Findings: Local—Process indolent, infiltrating, organizing, fibrosing, sclerosing and, later, deforming cicatrizations. Lesions begin at anterior nares—mucosal edematous nodules tending to

break down and discharge—later foul and crusty; progressive extensions and healings, apparently without limit.

General—Little or no change in red cell count, relatively high color index and rarely some changes in form of red cells; little or no change in number of leucocytes, but tendencies toward fewer polymorphonuclears and small lymphocytes and more transitionals and basophiles with eosinophilia; associated signs and symptoms of lower respiratory troubles of indefinite nature—possibly suggestive of tuberculosis—and gradual general debility with tendency to subnormal temperature.

Pathology—Microscopically the first change is excessive fluid pervading intercellular spaces of the submucosa; this undergoes fibrinization with sparse round cell infiltration, occasional "foamy" cells of Mikulicz (which are also found in glanders, lepra, bubonic plague and paratubercular lesions), four to five times the size of lymphocytes; in or around a foamy cell may be found scattered (never clumped, as are lepra bacilli) Frisch bacilli; occasional degenerated plasma cells which have been called "hyaline bodies" of Russell. As the lesions become older they show increasingly extensive invasions of areolar spaces, the new formed contracting fibrous tissues occupying places of former vascular and lymphatic structures. This "interposition" process is seen to separate, more and more, the basement membrane from lymph and vascular connections, with secondary dystrophic effects. Tenderness, tumor and cicatrizing fibrosis are notable gross pathologic characteristics; infiltrations and organizations increasingly impairing local nutrition and functional activities are the chief microscopic characteristics.

In 1908, Mayer reported having found record of only sixteen cases in the United States; early in life, females slightly more frequent than males; treatment, nothing satisfactory. In 1903 Fittig reported X-ray treatments of little value. In 1915, Brunner and Jobowsky reviewed treatment; mercury, arsenic, iodine, arspenamin, tuberculin, local caustics, actual cautery proved of no value; vaccine seemed to lessen extensions but was of no effect on sclerotic areas. Lubiner reports one case which improved following recovery from typhus. In 1928, Figi and Thompson reported having used radium, "with K. I. internally

as tenacious mucus required"; three cases were free of clinical evidence for one to three years and two cases were improved. In 1927, Kalin published an extensive review supplemented by personal observations: (1) Rhinoscleroma is infectious granuloma characterized by large round cells, hyaline changes and encapsulate bacillus of Frisch; (2) specificity of bacillus of Frisch supported by several immunobiologic reactions—agglutination, specific bactericidal properties and Bordet-Gengou's complement reaction; the latter may be used as a diagnostic aid in more or less obscure cases; (3) experiments in animals suggest infectious character of lesions; (4) among etiologic factors a number of biochemical deviations from normal such as marked increase in blood calcium and relative increase of potassium; (5) the protease of nasal secretions is increased; in this respect they are similar to ozena; (6) believes further studies of biochemical properties of the body and of nasal secretions may elucidate the pathogenesis and lead to prophylactic measures. In 1927 Robinson, using radium treatment, reports production of dense fibrosis* replacing loose granulation tissues of submucosa. He found that radium offers early cases chance for cure and advanced cases palliation and relief. Three of his early cases showed disappearance of neoplasm and three late cases relief from nasal obstruction for two to four years.

Impressions: From my observations the systemic factors in etiology seem of greater importance than local pathogenic factors. These systemic factors include: (1) Constitutional predisposition, (2) dietary deficiencies, with resulting (3) nutritional imbalance. Local pathogenic factors include: (1) Specific bacteria; (2) submucous fibrosis and secondary distorting contractions; (3) progressive mucosal changes, crusting and dryness—increasing impairments of upper respiratory functions.

Systemic therapy seems of paramount importance; local treatment of negligible value. Profound change in diet and high fluid intake should continue for months or years. Dietary details can

*In view of universal finding of dense fibrosis throughout submucosa as characteristic pathologic change, and typical absence of "loose granulation tissue" in rhinoscleroma, it seems probably erroneous to attribute "dense fibrosis" to effects of radium.

only be worked out in the course of each individual case, checked by clinical progress, body weight, blood and pulse pressures, hemograms, B. M. R. and local changes. In addition biochemic alternative adjuvant measures touching upon (1) electrolyte balance in tissues by two weeks' saturations with chlorides, phosphates, nitrates or sulphates; (2) upon metabolic tissue balance with calcium-atropin or various iodide saturations alternating with varying endocrine courses, and (3) upon bacterial and trophic conditions with arsenicals and mercurials. All these must be applied seriatim in conjunction with rigid adherence to diet. Local measures may be rarely required to meet occasional emergencies, but should be minimal. Rhinoscleroma seems pre-eminently a diet deficiency disease, in which there is a specific bacterial factor of relatively little pathogenic importance.

OSTEOMA: CASE REPORT.*

M. W., 37 years old, in July, 1931, was found to have a hard mass at the orifice of the left auditory canal. For a long period of time hearing had been negligibly impaired. For the previous two months she had noted occasional pain on pressure. The canal was occupied by a bony mass arising from the posterior and superior walls, leaving a narrow semilunar chink along the floor. It was impossible to obtain any view of the canal beyond the tumor. Biopsy diagnosis was not obtainable; she was examined by members of the otologic staff on several occasions. Clinical diagnosis of osteoma of external auditory canal was concurred in by all.

She gave family and personal histories of atopic troubles, and examinations revealed marked abnormalities in blood picture and metabolic rate. She was put on systemic treatment calculated to alter intercellular electrolyte content and cytoplasmic constitution. Her weight, pressures and clinical progress were checked weekly, later biweekly. During October acute external otitis developed for several weeks. By the middle of November the mass had grown markedly smaller, and on December 18th further recession was found. Examination by Dr. Moose, Dr.

*Reported at Western Section of the A. L., R. and O. Society, Los Angeles, January 30, 1932.

Weisross, Dr. Semenov and myself, on January 29th, showed only a small vestige, about the size of a pinhead.

This case has been watched during the course of treatment by Dr. Homer Walker (who referred her to my care), Dr. Herman Semenov, Dr. John Pratt of Minneapolis, Dr. Ray Moose of San Bernardino and others, whose concurrence in diagnosis of osteoma of external auditory canal has been unanimous. Radiologic and biopsy examinations of this mass were given careful consideration and decision was made against such measures for only one reason—in order to keep this study of recession under systemic treatment only, absolutely clean of any possible misinterpretation such as effects of X-radiation or of surgical removal of biopsy material. In deciding against confirmatory measures of this sort it was fully realized that this course closed the door to certain proofs of the nature of the lesion. It was the unanimous opinion of those who studied the lesion that it was so obviously an "exostosis," "hyperostosis" or "osteoma" (as may seem preferable terminologically) that further radiologic or biopsy proof was less to be desired than was the avoidance of any overt measure—such as radiation or biopsy removal—which might cloud the deductions in case of its subsidence under systemic treatment.

My own opinion is that this pathologic process is properly to be termed "periostitis osteoproliferans."

1154 ROOSEVELT BUILDING.

SECOND INTERNATIONAL CONGRESS OF OTOTOLOGY, RHINOLOGY AND LARYNGOLOGY.

The Second International Congress of Otology, Rhinology and Laryngology will be held in Madrid, Spain, from September 27th to 30th, 1932. The official studies determined upon at the First Congress, held in Copenhagen, were (a) Otosclerosis, (b) Ozena, (c) Scleroma. Reports upon these subjects will form part of a comprehensive program, which will feature, also, some endoscopic problems of the respiratory and digestive tracts and the treatment of malignant tumors by radiation.

Those desiring to enroll as members of the Congress are requested to forward the membership fee of \$10.00 to the Honorable Secretary, Doctor A. Fumagallo, Hermosilla, 2 Moderno, Madrid, Spain.

AMERICAN BOARD OF OTOLARYNGOLOGY.

An examination was given in New Orleans, Monday, May 9, 1932, at which forty-four candidates appeared: thirty-seven passed; seven failed.

The next examination will be held in Montreal, Canada, Saturday, September 17th, preceding the meeting of the American Academy of Ophthalmology and Otolaryngology.

After the Montreal examination the following requirements for examination will be effective:

1. A candidate acceptable for the examination must be a graduate of an approved medical school followed by at least one year of approved internship or three years of general practice.

2. In addition, a candidate must have completed an academic year as a basic course of otolaryngology or one year of internship in otolaryngology followed by two years of specialized practice.

3. Five years of specialized practice will be accepted in lieu of the requirements of paragraph two."

Those desiring to appear before this Board should obtain application blank from the Secretary—Dr. W. P. Wherry, 1500 Medical Arts Bldg., Omaha, Neb.

H. P. MOSHER, President.

Abstracts of Current Articles.

NOSE.

Nasal Obstruction and Systemic Consequence.

John J. Shea (Memphis, Tenn.). Trans. Am. Acad. Ophth. and Oto-Laryngol., 1931, xxxvi, 199-208.

The correction of nasal obstructions constitutes more than 60 per cent of nasal surgery. The systemic consequences of nasal obstruction depends on the age at which the obstruction occurred, modified by the individual characteristics.

Early obstruction tends to retard the pneumatization of the sinuses and the normal growth of the alae nasi and upper maxilla. During adolescence the turbinates should develop; if they do not, their growth will be retarded, and also be the cause of frequent colds and headaches. The reflexes, the result of adult obstruction, are manifested as headache, neuralgia, vasomotor rhinitis, asthma and emphysema. The lack of oxygen is manifested systematically by weakness, anemia and slow cerebration.

FRANK.

Personal Experience With Rhinoplastics.

Prof. A. Sercey (Zagreb). Otolaryngologica Slavica, 1931, Vol. III, page 415.

This is a very profusely illustrated article of the various types of rhinoplastic such as are well known and established. The results appear to be excellent.

There is one additional feature in this publication, and that is the histologic examinations of some of the transplants, particularly of cartilage that was subsequently examined, due to extrusion. It shows well the absorption of the cartilage cells and replacement by fibrotic changes, especially in the presence of infection.

BECK.

Some Experimental and Clinical Observations on the "Reticulo-Endothelial" Components of Accessory Sinus Mucosa.

R. A. Fenton and O. Larsell (Portland, Ore.) Trans. Am. Acad. Ophth. and Oto-Laryngol., 1931, xxxvi, 225-238.

The experimental investigations of the authors in cats with traumatized frontal sinuses have shown that in these animals

(whose normal sinus mucosa strongly resembles the human sinus mucosa) the mucosa contains histiocytes in small numbers near the blood vessels. Physical trauma and bacterial inoculation cause their arrival in large numbers. These cells are the first line of defense and repair, appearing ahead of the polymorphonuclears and the lymphocytes. Further investigation is necessary to find methods for artificially increasing the number of histiocytes.

FRANK.

A Consideration of the Catarrhal States in Relation to Diet.

I. H. P. Paton, M. B., Ch. B. (St. Andrews), *Edinburgh Medical Journal*, August, 1931. New Series, Vol. xxxviii, No. 8, page 468.

Observations have been made that during the great war there was a definite reduction in duration of catarrhal states. Many explanations have been offered, but none seems to stand critical examination so well as that which suggests the relationship that exists between catarrhal diathesis and the consumption of sugar. Rationing of sugar during the war, the author believes, was the main reason for the reduction in duration of the common catarrhal states. The bulk of temporary disability in the British Isles is due to respiratory catarrh. Since the war the consumption of sugar has increased enormously, so, too, has the duration of respiratory catarrh. Among the schools it is noticed that respiratory catarrhs are most frequent when the pupils have greater access to sugar, such as during school holidays or home visits.

Many other states of ill health are known to be related to excessive sugar consumption. A definite lessening of the amount of sugar used by the people of the British Isles is suggested as one way to lessen very materially the national morbidity.

GOLDSMITH.

The Relation of the Lymphatic System of the Nose With That of the Cranial Cavity.

Von W'a. Cszhudoosowetow. *Otolaryngologica Slavica*, 1931, Vol. III, page 393.

This article deals with the experimental work on injected lymphatics of a dog. Well illustrated are the injections of the lymphatics, particularly of the septum and the olfactory fissure. The important part brought out is to definitely differentiate between the venous injection and the lymphatic injection.

Microscopic studies of preparations of the experiments definitely prove the connection between the nose and the lymphatics of the nose and the arachnoid spaces.

The conclusions are about as follows:

1. That there exists a connection between the subarachnoid space and the lymph spaces of the nasal cavity.
2. That the connection is principally by way of the perineural lymph spaces—that is, of the olfactory nerves.
3. That the subaretnoid space and the lymphatic system of the nasal cavity are two entirely separate systems; that they do connect by very fine anastomosis by means of the peri- and epineural routes.
4. That the lymph spaces of the nose are intimately connected with lymphatics of the external nose, thus showing that an infection from an external nasal affection need not be by vascular or venous routes but really by the lymphatic routes directly into the subaretnoid space and on to the intracranial structures. BECK.

Intranasal Cure of Fistulized Frontal Sinusitis. (Cure endonasale de sinusite frontale fistulisée.)

Dr. P. Guns (Louvain). Ann. d'Oto-Lar., Dec., 1931, p. 1190.

Disagreeing with Lillie and Anderson, the author maintains the views of Halle, Janssen, Wodak, Benjamins and others, preferring to enlarge the nasofrontal canal with mallet and gouge, traversing the agger nasi. He feels that too little attention has been paid to the enlargement of the nasofrontal duct and too much to curettage of the sinus mucosa. He urges obliteration of all partial partitions in the sinus, and states that the external fistula heals in a couple of weeks if a good, large intranasal opening has been secured. FENTON.

Postoperative Complications of the Radical Operation on the External Frontal Sinus.

Dr. Harold I. Lillie (Rochester). Trans. Am. Laryng. Assoc., 1931, p. 136.

In general, if manifest disease of the external table existed before operation, if there was a tumor within the frontal sinus, if the anatomic arrangement of the sinus made operation necessary, or if there were symptoms of intracranial extension, the Killian operation or some modification of it was used; otherwise, the Lynch type of operation was used.

The complications encountered varied from chemosis of the orbital and ocular conjunctiva to meningitis and abscess of the brain. Usually the only untoward result was some discomfort and delay in convalescence. At the Mayo Clinic, ether administered by the intratracheal method has been found satisfactory.

In the series of 158 consecutive cases in which a radical operation was performed on the external frontal sinus, slight postoperative complications developed in forty-five cases. Three deaths occurred, two from meningitis and one from abscess of the brain. The ordinary convalescence of a patient without complications requires seven or eight days in the hospital and observation afterward of about the same length of time.

IMPERATORI.

The Natural Orifice of the Maxillary Sinus: Anatomic Studies.

Dr. Mervin C. Myerson (New York). Trans. Amer. Laryng. Assoc., 1931, p. 146.

One hundred and fourteen lateral nasal walls were studied, and observations and measurements were made to ascertain the size, shape, direction and relations of the maxillary ostium. Accessory ostia were also studied in a like manner. It was noted that the orifice lies in a horizontal, vertical or oblique position. The posterior angle formed between the bulla and the uncinate process was found to be the most constant guide to the approach to the orifice. Numerous tables and drawings showing the results of this study were presented. The study was undertaken to establish the practicability or impracticability of irrigating the antrum through the natural opening.

IMPERATORI.

PHARYNX.

Highly Malignant Tumors of the Nasopharynx and Pharynx.

G. B. Newe (Rochester, Minn.). Trans. Am. Acad. Ophthal. and Otolaryngol., 1931, xxxvi, 39-43.

At the Mayo Clinic, in a period of fourteen years, 246 patients with highly malignant tumors of the nasopharynx and pharynx were examined. Of these, 191 were epitheliomas and 55 were lymphosarcomas; 194 were nasopharyngeal and 52 were pharyngeal.

Tumors of the nasopharynx and pharynx, frequently classified as lympho-epitheliomas and transitional cell carcinomas, are squamous-cell epithelioma graded 4.

Unless patients with such malignant tumors are seen early and can obtain adequate treatment, little is accomplished in prolonging life by palliative treatment. The average length of life of the patients in this series—28 per cent—who received treatment was 34.4 months. The patients who did not receive treatment lived an average of 6.8 months.

FRANK.

Some Notes Concerning Anomalies in the Development of the Secondary Branchial Clefts.

Prof. Ant. Precechtel (Prague), Otolaryngologica Slavica, Vol. III, 1931.

The author classifies these maldevelopments according to the location of the fistula, showing a very nice comparative illustration. These varieties of fistulae or maldevelopments are further illustrated by cases in the author's own practice, particularly emphasizing the surgery and preparations that were removed, both grossly and microscopically.

BECK.

Epidemic Encephalitis—Pharyngeal and Laryngeal Sequelae. (Les "sequelles" Pharyngo-laryngées de l'encephalite épidémique.)

Prof. J. Terracol (Montpellier). Rev. d'Oto-Neuro-Oph., 9:681, Nov., 1931.

Parkinsonian manifestations may be found after encephalitis in every structure concerned in speech, but these difficulties are especially noticed in the tongue and the palate. The tongue is protruded with difficulty or laterally; fibrillation is noted and occasional hemiatrophy has been found. The soft palate is relaxed, immobile, often lower on one side or with uvular deviation; the palatine reflex is sometimes slow, generally normal. The ordinary pharyngeal reflex is usually unaltered.

FENTON.

LARYNX.

A Permanent Tracheostomy in Stenosis of the Larynx.

Sir St. Clair Thomson (London), Journal of Laryngology and Otology, December, 1931, Vol. xlv, No. 12, page 817.

This paper gives the long experience of the author in dealing with laryngeal stricture and refutes many of the accepted dogmas with regard to the pitiful condition in which a person is placed who has to permanently wear a tracheotomy tube.

The operation generally undertaken with reluctance is frequently delayed until its execution becomes difficult and sometimes useless. A badly executed tracheotomy is the most frequent cause

of laryngeal stenosis. So too is unreasonable and unwarranted haste in removal of the tube. There is then the paradox that laryngeal stricture due to a badly performed tracheotomy is best treated by another but correctly executed opening of the trachea. Wearing a good sized canula tends to expansion of the glottis.

The chief reason advanced for getting rid of a tracheotomy tube is that it is unphysiologic to inspire into the lungs air that is not warm, moist and filtered. The author points out that the greatest value of nasal respiration is in childhood and early life.

The usual operation error is to divide the first ring of the trachea, or even the cricoid, and so introduce the canula into the narrow, vascular, glandular or sensitive subglottic larynx and not into the more spacious trachea. This accounts for the continued irritation these patients have, and the catarrh is usually incorrectly ascribed to the inspiration of cold air.

Social disability has been grossly exaggerated. Excessive secretion is absent in a properly executed operation. This opening may readily be hidden by or behind a man's collar or the chiffon most ladies wear around the neck, with a speaking valve attachment. The voice is so easily produced as to often be quite normal. The tube need only be removed for cleansing every few months. Cases are recorded where tubes have been worn from fifty to seventy years, yet the patients have never had bronchitis. Many instances were recorded where patients have borne children and lived an active life enjoying various sports, dances, etc.

GOLDSMITH.

A Plea for the "Window" Resection Method in Dealing With Certain Types of Laryngeal Carcinoma, With a Clinical History of Seven Cases.

Norman Patterson (London), Journal of Laryngology and Otology, February, 1932, Vol. xlvii, No. 11, page 81.

In all, seven cases of laryngeal cancer were treated by "window" resection; all were unsuitable for thyrofixure, and had the window resection not been available laryngectomy was the only alternative. When the posterior part of the larynx is invaded with carcinoma, the only operation holding out any hope of cure is total laryngectomy. In the author's opinion, ray therapy should be reserved for inoperable cases.

The author stresses the safety of the operation if the patients are carefully selected. The results as regards freedom from recurrence is as good as in total extirpation. The mutilation is infinitely less, and the outlook with regard to voice and respiration may be as good as after fissure. Lack's technic with a few modifications is adopted. The underlying principle is to take away as much cartilage (thyroid and cricoid) that the tumor can be mobilized during removal. It matters little if a true window is cut or most of the structure removed.

The author thinks the window operation should be more often performed as an alternative to laryngectomy, the chief indications being (1) When the disease is limited to the anterior portion of the larynx and has crossed the middle line and involved both cords. Even the whole of one cord and the anterior third of the other may be invaded and yet a partial operation may prove successful. If one arytenoid and a portion of the corresponding cord can be conserved, sufficient space may be left after the healing has taken place for phonation and possibly for respiration. If the tracheal opening has to be maintained the patient is still in the possession of something which may be dignified by the name of a larynx, and a voice, though husky, is produced in a physiologic manner. (2) Extension of the tumor downwards is no bar to "window" resection. So long as the growth is situated in front of the larynx it can be removed by taking away the anterior portion of the cricothyroid membrane and resecting the part of the cricoid cartilage which overlies the tumor. The principle of obtaining an adequate exposure of the tumor before attempting its removal can be carried out equally as well in this operation as in the operation of laryngofissure.

Of the seven cases reported, six occurred in private practice. Unfortunately, patients of the hospital class suffering from laryngeal cancer frequently do not report themselves until it is too late for surgical intervention, or until no operation short of laryngectomy can be entertained. Case 1 had several operations, commencing with laryngofissure. He is well, thirteen years after this operation, performed in 1918. Case 2 died shortly after operation—the result of bronchopneumonia. He had the rare complications, discovered postmortem, of carcinomatous glands in the neighbor-

hood of the tracheal bifurcation. Case 3 is free from recurrence five years after operation. He has no dyspnea. Case 4 died eighteen months after operation from "cerebellar thrombosis or hemorrhage." He was seen a short time before death and was free from recurrence. Case 5 died of heart disease three years and eight months after operation. Five months prior to death he was examined and the larynx was found healthy. Case 6 is well three years and nine months after operation. Case 7 died a little over five months after operation. This patient should have been subjected to laryngectomy.

GOLDSMITH.

Laryngeal Cysts. (Les kystes du larynx.)

Prof. J. Terracol (Montpellier). Ann. d'Oto.-Lar., Dec., 1931, p. 1141.

Two types are described; first, a cystic lesion of the larynx proper, generally found on the cords, small in size, sessile, containing either serum, blood, milky or cheesy material; the surface is netted by small vessels. These are retention cysts from the glands of the normal epithelium and are entirely benign, and may be removed by ordinary surgical measures without recurrence. The second type is the branchial cyst, lateral to the larynx and encroaching upon it from above. In the case of this type reported, cancerous changes had occurred in the cyst wall external to the larynx. Diagnosis by radiographs is very valuable in such cases. Radical surgery followed by radium apparently cured the second case.

FENTON.

EAR.

Experimental Investigation of the Equilibrium Mechanism of the Frog's Labyrinth.

W. J. McNally (Montreal). Trans. Am. Acad. Ophth. and Oto-Laryngol., 1931, xxxvi, 282-305.

The author, in the Department of Physiology, McGill University, has carried out a series of experimental investigations on frogs to determine the influence of the labyrinth on the body and limb musculature rather than upon the eyes, and he has made a special effort to determine just what part the labyrinth plays in everyday life.

From these experiments the author reaches the following conclusions:

1. Section of the nerve to the ampulla is the most satisfactory method of functionally removing a semicircular canal.
2. All parts of the vestibular labyrinth are concerned in the normal reactions of the frog to rotation about a vertical axis.
3. The vertical canals and the utricles are concerned in the frog's normal reaction to sudden tipping about a horizontal axis.
4. The horizontal canals bring about the counter turning reactions to rotation about a vertical axis which tend to retain the animal's original field of vision.
5. The vertical canals help to keep the head level during movement, and if any one vertical canal is absent there is an unsteadiness at that corner of the body corresponding to the absent canal.
6. The dipping of the head to one side, in the absence of the utricles, during rotation about a vertical axis, is most likely brought about by stimulation of the posterior vertical canal on the side to which the frog is being rotated.
7. A posterior vertical canal always gives the same type of muscle response, whether it is being stimulated during rotation about a horizontal axis or during rotation about a vertical axis.
8. The vertical canals are stimulated during rotation about a horizontal or vertical axis.
9. The horizontal canals and the utricles are evidently essential for forward progression in the frog, because in their absence the animal is condemned to shuffle about in a small area.
10. The semicircular canals are a factor in the maintenance of the normal posture of the frog. In the absence of any one canal there is a slight alteration in the normal resting pose of the animal, which is characteristic for that canal, and which we have called a "decanalicate posture."
11. The semicircular canals influence the normal tonus of the neck muscles. In the absence of the canals the head is found to be quite flaccid.
12. The frog's righting reaction is independent of the utricle or of any other special part of the vestibular mechanism and is present so long as any one canal or utricle is intact to initiate the reaction.

13. A frog with one utricle removed can be made to assume a symmetrical posture under certain conditions. If the adequate stimulus of the utricle is simple pressure of its otolith, this should not be possible.

14. In the absence of the vertical canals the utricles initiate wrong responses when the frog is tipped suddenly about a horizontal axis. Normally the canals must exert a checking influence upon the utricles.

15. The chin-lift and chin-drop tests are a great aid in diagnosis of a semicircular canal lesion in the frog. FRANK.

General and Otologic Aspects of Cholesterin Metabolism.

M. Fineberg (St. Louis). *Trans. Am. Acad. Ophth. and Oto-Laryngol.*, 1931, xxxvi, 248-261.

The author believes that there is a definite connecting link which may be found in the cholesterin metabolism in cases of arteriosclerosis, essential hypertension, apoplexy, chronic nephritis due to contracted kidney and progressive internal ear deafness. There is a very clearly marked hypocholesterinemia in all these conditions which is not coincidental but etiologic. The author cites the work of others and his own histologic and other findings in nineteen personally studied cases to show that the systematic clinical, anatomic, pathologic and experimental investigations establish the validity of the contention which he maintains as above. FRANK.

A New Procedure in the Radical Operation in Chronic Suppuration of the Middle Ear.

Dr. Jan Miodonski (Krakau), *Otologica Slavica*, Vol. III, 1931.

As usual, there is a complete review of the literature. Almost anyone that has published anything on this subject in the European clinics is referred to, but nowhere is there any mention of an American or English author. The procedure is something that the abstractor is very familiar with and was first performed by Dr. Leland of Boston, namely, forming a skin flap from the back of the auricle and laying it into the exenterated cavity. It is at least twenty years old. BECK.

Three Cases of Malignancy of the Ear.

B. S. Goland (Kasan), *Otologica Slavica*, Vol. III, 1931.

Case 1 is a carcinoma retro-auricular, originating from the skin. The ear itself is not involved. The pathologic diagnosis is

an epidermoid carcinoma of anaplastic variety, nondifferentiated with a great deal of mitosis.

Case 2 is a squamous cell carcinoma of the mastoid process with involvement of the facial canal and nerve. The case was radically operated on and subsequently irradiated with apparently no recurrence several months after the treatment.

Case 3 is a very extensive sarcoma of the external ear and involvement of the entire temporal bone, invading the intracranial structure. Although an attempt at surgery was made, it was soon followed by a complicating intracranial infection with a fatal termination. The case was posted and found to be extensively involved in metastasis throughout the body, particularly the liver and the glands. The microscopic type of the sarcoma was that of a medium size spindle cell with very little if any stroma.

The article goes on, very extensively reviewing the history of malignant tumors about the ear, and one of the most complete literary references accompanies the article.

BECK.

Epidemic Encephalitis—Cochlear Function. (Recherches sur la fonction cochléaire chez les parkinsoniens post-encéphalitiques.)

Dr. Giorgio Ferreri (Perugia). *Rev. d'Oto-Neuro-Oph.*, 9:689, Nov., 1931.

Augmenting the extensive report of Portmann to the French Congress of Oto-Neuro-Ophthalmology, Ferreri fails to locate any constant type of sound defect traceable to encephalitis. Slight lesions of the nerve deafness type, especially for high forks, seemed the most frequent.

FENTON.

Eruptions Involving the External Auditory Meatus.

H. W. Barber, M. B., F. R. C. P. (London). *Journal of Laryngology and Otology*, September, 1931, Vol. xlii, No. 9, page 589.

The majority of cases of so-called eczema of the external auditory meatus are really examples of infective meatitis. The modern dermatologic conception of that much abused word—"eczema"—insists that such a diagnosis without a rider as to its certain or probable cause is no diagnosis at all. The commonest cause of infective meatitis is undoubtedly the pityrosporon or spor of Malassez wrongly christened "Flaschenbacillen" by Unna. This spor may so damage the horny layer of the skin that the streptococcus and staphylococcus aureus easily establish themselves.

The author discusses the subject under the following heads: (1) Eruptions due to external infections, (2) Eruptions due to infective organisms reaching the skin through the blood stream, (3) Eruptions of internal origin and allergic in nature, (4) Eruptions due to involvement of the cutaneous nerve or nerve ganglia.

GOLDSMITH.

"Cephalic Nystagmus" of Posture. (Onistagmo cefalico de posição.)

Dr. P. Mangabeira Albernas. (São Paulo). Rev. Oto-Neuro-Oft., Süd Americana, 6:489, Dec., 1931.

Nodding or rotation of the head in response to vestibular stimulation is rare, but has been reported by Borries, Rutin, Suzuki and Nishibata. The author's case, very carefully reported, is unique in that the anteroposterior jerking arose spontaneously, only when the head was placed 90° backward; no ocular nystagmus was observed. Caloric and fistula tests gave negative results as to head jerking and much reduced ocular responses. The case was four plus Wassermann, and his headache and postural disturbance yielded rapidly to sulphoxyl-salvarsan. The author considers that the otolith system and semicircular canals were both involved in this unusual manifestation.

FENTON.

MISCELLANEOUS.

The Examination of Living Cells.

Dr. Harris P. Mosher (Boston). Trans. Am. Laryng. Assoc., 1931, p. 27.

Observations on thirty-five consecutive specimens of mostly antral mucous membrane, removed at operation in cases of chronic maxillary sinusitis, were reported. Living cilia were found in every specimen.

IMPERATORI.

Scleroma of the Trachea and Bronchi.

Dr. J. Hybasck (Prague). Otolaryngologica Slavica, Vol. III, 1931.

He has the usual extensive review of the literature up to the present moment, then case reports with very nice illustrations of the tracheal bronchoscopic pictures. Also some gross specimens of material removed from these parts for further diagnosis. These scleroma cases were mostly of local—that is, Czecho-Slovakian habitats. Particularly interesting was a case in which vaccine, obtained from the secretions by suction, was used. Unfortunately the organism is not mentioned in that case, so it is assumed by the abstractor that it was a polyvalent organism.

BECK.

The Government Aspect of Aviation.

L. H. Bauer (Hempstead, N. Y.). *Trans. Am. Acad. Ophth. and Otolaryngol.*, 1931, xxxvi, 306-310.

The author is the Medical Director of the Aeronautics Branch of the Department of Commerce and it is his duty to devise regulations for selecting civil flyers. He states that flying is no longer thought to be an ear problem; it is a problem of eyes and nervous system.

Transport and commercial pilots are examined twice a year; private and student pilots once a year. There are now over 16,000 licensed pilots in this country; about half are private pilots; about 1,700 are limited commercial pilots and approximately 6,000 are transport pilots. There are 800 qualified medical examiners, all of whom have the special qualifications necessary for this work.

A study of the records of the licensed pilots reveals that only about 7 per cent of the transport pilots have physical defects even trifling in character.

The chances of being able to learn to fly is in direct proportion to the absence of severe physical defects, and the accident and fatality rates are far higher among pilots with physical defects than among those who are physically normal. FRANK.

Bleeding and Hemorrhages in the Respiratory Tract Following the Therapeutic Pneumothorax in Tuberculous Individuals.

Dr. I. Frankel (Kiev), *Otolaryngologica Slavica*, Vol. III, 1931.

He reviews the literature up to the time of his publication, giving a table of ten cases showing classified the various procedures, results, and especially the points of bleeding. The explanation of these hemorrhages is that they are supposed to be due to the increase of blood pressure, as well as to the irritation to cough that often follows artificial pneumothorax. BECK.

The Relationship Between Status Lymphaticus, the Thymus and the Suprarenal Glands.

Dr. Edward H. Campbell (Philadelphia). *Trans. Am. Laryng. Assoc.*, 1931, p. 43.

In addition to the type of status lymphaticus in which an occasional sudden death occurs, statistics mentioned show that there are milder grades of this condition commonly present which contribute to the ill health of many people. Difficulty in ascertaining

the true size of the thymus was taken into consideration, and statistics on the occurrence of an enlarged thymus were mentioned.

The subject of roentgenography of the thymus was considered in some detail, doubt being expressed that it was of any value in the hands of many roentgenologists in depicting the size of the gland.

Dr. Campbell discussed the question as to whether or not roentgen treatment for an enlarged thymus preliminary to tonsillectomy is of any value.

Statistics were mentioned which showed that the enlarged thymus is only a symptom of status lymphaticus, which in turn is due to a deficiency of the suprarenal hormones.

IMPERATORI.

ABSTRACT OF TRANSACTIONS OF THE AMERICAN
OTOLOGICAL SOCIETY.

(Continued from the March Issue.)

THURSDAY, JUNE 18, 1931—AFTERNOON SESSION.

Function of the Tensor Tympani Muscle. (Experimental Study)¹

DR. SAMUEL J. CROWE,

BALTIMORE

There are functional impairments of unknown etiology that affect both ears equally. The low tones are heard normally and the greatest impairment is for tones above middle *c*. Air conduction in these cases is better than bone conduction, although in some patients it seems shortened and in others it is normal for the 256 double vibration and the 512 double vibration forks. This condition is described in the literature as an inner ear lesion and due to constant neuritis of the acoustic nerve or to neuritonal disturbances of the basal coil of the cochlea. In the Otological Research Laboratory of the Johns Hopkins University, the drum membrane and upper air passages are carefully examined and a careful tuning fork and audiometer test made of as large a percentage of the patients as possible who have some serious systemic disorder. Many temporal bones have been sectioned and the pathological changes correlated with the clinical findings and the functional tests. In a large group of cases with marked impairment for high tones, no lesion could be found in the inner ear.

The phenomenon described in 1930 by Wever and Bray gives us a new method with which it is possible for the first time to determine in experimental animals the part played by the tympanic membrane, ossicles, round window membrane, eustachian tube, stapedius and tensor tympani muscles in the transmission of the voice and tuning fork tones. It also enables us to study the transmission of high tones in relation to middle ear structures.

In a recent number of the *Journal of the American Medical Association* we published the results of an experimental investigation on the function of the round window membrane in the cat.

A similar investigation was made on the function of the tensor tympani muscle of the cat. Intratracheal ether is used in all experiments. The mastoid bulla is exposed through an incision in the neck, opened, and the tensor tympani muscle and tendon brought into view by opening the middle ear cavity. In a preliminary series of ten experiments, the effect of tension on the tensor tympani muscle was studied.

The fact is demonstrated, therefore, that with extreme tension on the tensor tympani muscle and the consequent fixation of the ossicular chain, transmission of all tones below 2048 is reduced until they are no longer audible. This is analogous to the fixation of the stapes in patients with adhesions or otosclerosis, or fixation of the head of the malleus and incus from an inflammatory process in the attic.

In another series of experiments the effect of division of the tensor tympani tendon was studied. If the tendon is divided and the animal tested immediately afterwards there is no appreciable effect upon the transmission of sound. If the tendon is divided with sterile precautions and tests made two days later there is again no demonstrable effect on sound transmission. If the animal is tested ten days after the division of the tendon, however, a very striking and constant effect is noted, provided there is no infection of the wound and no interference with transmission due to a blood clot in the middle ear.

It can be seen from a study of this experiment that nine days after section of the tensor tympani tendon the 256 and 512 tuning forks are heard with normal intensity. Higher tones are almost completely inaudible in the loud speaker. This effect has been observed in a series of seven animals. The clarity and volume of the lower tones may be somewhat reduced, but the transmission of the higher tones is always much impaired, in striking contrast to the effect of tension on the ossicular chain. In no other procedure, and practically all the more common pathologic conditions in the middle ear have been duplicated in the course of these investigations, has it been possible to eliminate or reduce the transmission of high tones without, at the same time, reducing low tones to an equal or to a greater degree.

Another striking phenomenon was observed in this series of experiments. After an almost complete elimination of the transmission of high tones, pressure on the round window membrane counteracts the effect of the division of the tensor tympani tendon, and the transmission of high tones returns with a volume and clarity better than that observed in normal animals. This effect in our series of experiments has been invariable and constant.

These experiments clarify our ideas about the tensor tympani muscle and suggest that impairment of function of this muscle may be one of the common causes of the impairment, not the loss, of high tones in patients. If this proves to be the case, we will have to modify one of the fundamental otologic concepts that "A loss of high tones is always due to an inner ear lesion and cannot be restored by treatment." The tensor muscle in man lies adjacent to the eustachian tube and is even more exposed to infection than the intrinsic muscles of the larynx. The experiments on the result of fixation of the round window membrane indicate that this procedure increases the sensitivity of the cochlear end organ and more than counteracts the deafness caused by lesions in the middle ear. We are encouraged to hope that in suitable cases the simple operation of placing a fascial graft firmly against the round window membrane, by rendering it immobile, will restore a useful degree of hearing in deaf patients.

DISCUSSION.

MR. R. L. WEGEL, New York: Dr. Crowe has inaugurated a program of investigation utilizing as a tool the Wever and Bray method of observing response of the end organ by means of what is held to be the action potentials on the eighth nerve resulting from auditory stimuli. He is to be congratulated on the promptness with which he recognized the value of this method and on the excellence of the preliminary results which he has obtained. In so far as these results can be interpreted with safety, they are in accord with previous knowledge of ear mechanics, but there no doubt are many experiments which can be performed and which, with present lack of mechanical information, cannot be predicted.

The artificial lesions which Dr. Crowe has introduced into the tympanum are, I take it, rather definite approximations to cer-

tain pathologic conditions and as such should be of the highest value in interpretation of functional tests and, as he suggests, in the mode of treatment. From a physical standpoint, however, they are not always interpretable. Thus, when he introduces tension on the tendon of the tensor tympani, he stimulates a pathologic condition—fixation of the ossicular chain. He also makes an easily interpretable physical change, that is, an increase in the rigidity of the transmitting mechanism. The observation that low frequencies suffer principally is in accord with predictions made on physical grounds and described a number of times during the past decade in the *Transactions of the Society*. When a pledget of cotton is introduced with pressure into the niche of the round window, the pathological condition of spurious tissue growth there is simulated. The physical condition which is thus produced is, however, difficult to describe. He refers to the condition as that of making the round window "rigid." This is no doubt a proper technical use of the term in pathology but it is incorrect to presume that he intends it in a technical physical sense. The distinction is important to bear in mind in order to avoid ambiguity. Fortunately, such an experiment has a direct practical bearing regardless of its physical significance, but a use of the findings to infer characteristics of the physical mechanism of hearing cannot be made without recourse to a more abstract analysis.

In interpreting the results of experiments such as those obtained by this method, it is necessary to have in mind also the results of other kinds of research. The conception of a single more or less limited region of stimulation of the organ of Corti in response to each single frequency has been found to be in accord with a large quantity of various tests on human ears and with mathematical analysis as far as this has been carried. Details of this conception have been frequently described in the *Transactions*, but there is one feature of it which has not been stressed and which is pertinent to the use of the method of Wever and Bray. The basilar membrane is presumed to vibrate along its entire length in response to any single frequency, but with a maximum of violence in a certain rather narrow region located at a point which is characteristic of that frequency. It is an im-

plication of dynamics that such vibration as exists on the proximal side of this characteristic region, is in phase or in step with the motion of the stapes, that the large vibration at the center of the active region lags behind the stapes motion by 90° or one-fourth step, and that the smaller vibration distal to the active region lags by 180° , or one-half step. From one end of the basilar membrane to the other, therefore, there is a continuous transition in lag of the stimulus through a range of one-half step. Each vibration must, therefore, cause a stimulus similar to that which would be obtained by sweeping a fine stylus along the organ of Corti from the proximal to the distal end in one-half cycle with extra heavy pressure at the region characteristic of the frequency which this hypothetical process is supposed to stimulate. In the Wever and Bray experiment the frequency of the potential observed is that of the stimulus. It must, therefore, be concluded that generally the excitation takes place only once in each cycle. In order to complete the analogy with the stylus, the remaining half of the cycle of vibration must be represented by a pause. Each successive cycle is then represented by another sweep of the stylus, of duration one-half cycle and pause for one-half cycle.

The consequence of such a conception is that for a sufficiently low frequency a succession of impulses are sent up the eighth nerve trunk, the first of these traveling on those fibers terminating proximal to the center of the active area and the last on those fibers terminating distal to it. Thus the end organ of hearing is radically different as a nerve irritant from the stimulating electrodes applied to a nerve trunk when observing action potentials. In the latter case all fibers of the trunk are stimulated simultaneously and, except for propagation velocity differences in the separate fibers, results in the impulses traveling together. When a nerve is stimulated by the end organ of hearing the impulses are sent up the nerve in echelon formation.

It is an accepted doctrine among physiologists that a single nerve fiber is capable of transmitting a succession of impulses not exceeding a certain definite frequency which depends on the frequency, intensity and other characteristics of the stimulus. The maximum frequency given for fibers of the eighth nerve is given as lying between 600 and 1000 per second. Although the

frequencies observed in the Wever and Bray experiment are well into the thousands, there seems as yet to be no contradiction, for when the separate fiber potentials proceed in echelon the limited frequency observable as an action potential is set not by that of one fiber or by the trunk as usually stimulated, but by the product of the maximum rate for one fiber by the number of fibers excited. These separate impulses are associated with unidirectional potentials which are substantially constant in magnitude so the magnitude of the observable action potential for echelon stimulation is expected to be less than that for simultaneous stimulation and approaching as a minimum the magnitude characteristic of a single fiber. For higher frequencies that part of the composite potential which is available at the electrodes as a frequency must then consist of a ripple superimposed on a relatively large unidirectional negative potential. The magnitude of this ripple must then decrease as the frequency is increased. Reasons have recently been given by Adrian (*Journal of Physiology*, 71, No. 4) for concluding that the Wever and Bray potentials are not nerve action potentials but rather the exciting potentials within the cochlea, presumably generated by the hair cells. It would seem reasonable to expect that the potentials observed in this experiment result from a combination of both and it is Adrian's contention that under the conditions of the experiment the latter predominate.

DR. G. E. SHAMBAUGH, Chicago: I approach a discussion of this subject with hesitation. I feel incompetent, first, from the standpoint of the physiologist, and second, from the standpoint of the physicist. Because of these two reasons, I am puzzled over the phenomena observed. The physical impulses of sound waves I can understand. These impulses pass into the external auditory meatus, impinge upon the drum membrane, pass through the chain of ossicles, the footplate of the stapes, the perilymph, through Reissner's membrane into the endolymph, all as physical impulses, but here the sound waves impinge upon the organ of Corti and are transformed into nerve impulses which when they pass over the auditory nerve to the brain centers in the cortex are interpreted as sound. The impulse is physical when it enters the ear. When it leaves the ear it is a nerve impulse. According

to the Princeton experiment, the nerve impulse as it passes through the auditory nerve is picked up electrically and by means of amplifiers we get the original physical impulse again. *A priori*, it would seem that since it requires an elaborate mechanism such as the organ of Corti for the transference of physical impulses of sound waves to nerve impulses, some such similar complex transformation would be necessary before we can get back to the physical impulses. I do not doubt the results obtained by this experiment; I only question the explanation. In my ignorance I find it hard to comprehend how a nerve impulse can be picked up and recognized as a physical sound impulse. It would seem to me that there must be some other physical impulse that accompanied the nerve impulse of sound waves that are picked up in this manner. This experiment seems to give us a means of prying into the secrets of the cochlear mechanism.

DR. JOHN GUTTMAN, New York: This work, I believe, will modify many of our former notions regarding the physiology of hearing. I am working in a similar line, but I am not yet ready to give the results of my experiments.

Kato Lüscher and others have shown that the intratympanic muscles contract at every sound impulse and play an important part in the transmission of sound. The experiments of Dr. Crowe have shown that if the round window was closed by plaster of Paris no change was noticed in the transmission of sound, but cotton or soft wax improved the transmission of sound. This is at variance with the conception of Alexander, who claims that the round window is the most important avenue for the transmission of sound.

In the eye the optic nerve is not sensitive to light; it is rather difficult to imagine why the cochlear nerve should be sensitive to sound if we assume that the transmission of sound is not of physical but of physiological nature.

I must agree with Dr. Shambaugh who stated that, while we do not doubt the correctness of the observations, the interpretations of the observations may still be doubtful.

DR. EDMOND P. FOWLER, New York: What Dr. Crowe says actually takes place. I saw the experiments and repeated them

myself and every time we got the same result. The apparatus was accurate as far as measuring the frequency went but the estimations of intensity were only qualitative by radio amplifiers; one must allow for this fact in estimating the data. As far as the oval window is concerned, it is apparent that if an impulse goes by way of the stapes into the scala vestibuli, and out by way of the scala tympani, the round window must act as a sort of escape mechanism for the impulse. I believe when Crowe presses on the round window he is also making pressure upon the stapes, and putting tension on the ossicles. The way to determine this is to allow sufficient time to elapse for the normal intralabyrinthine pressure to be established, and test again. If it is found that hearing is diminished or increased it is certain that the effect is not due to articular changes.

DR. LESTER M. HUBBY, New York: I had a case of hyperacusis occurring many years after a mastoid operation in which the incus had been removed. There was decreased hearing, but with the attack of acute otitis there was tremendous hyperacusis; so much so that it was painful for the boy. Perhaps this theory of Dr. Crowe may account for this by the fact that there may have been thickening or increased tension of the membrana secundaria with increased acusis.

DR. D. HAROLD WALKER, Boston: Dr. Blake wrote an article on "Tension Anomalies of the Middle Ear," which would be interesting to review, as it describes his work upon the middle ear. He was interested in the physics of sound production, and speech. His work was partly responsible for the construction of the Bell telephone. He used paper splints for relaxed drums caused by overinflation, and also in cases where there was no drum. He improved the hearing often by placing cotton pledgets with vaselin over the stapes as well as over the round window. I think the improvement in hearing, as Dr. Crowe reports, is due to a reduplication of sound, like an echo, which is caused by blocking the round window. This was confirmed by Blake, and also by my experiments. I think the more we follow the principle of the telephone and microphone, the better we can understand how the physical energy is transformed into electrical energy

and then transmitted to the brain. I think the hair cells are where this change occurs, and the sound analysis takes place in the hearing centers in the cortex.

DR. HARVEY FLETCHER, New York: One thing that interested me was that Dr. Crowe said that doing things that one would expect to affect the hearing did not affect it. If we look at audiogram charts a small sensation unit change does not seem to affect hearing much one way or the other, but we must remember that a reduction of 20 sensation units means that you get only one-tenth of the amplitude of motion of the drum. You would not expect to get a large change in sensation units by doing something mechanical, but if you shift more than 30 units you have reduced the power output of the machine to one-tenth of 1 per cent. Dr. Crowe makes certain mechanical changes in the middle ear, but he will have to have more precise means of measurement before he can determine the effect upon the hearing. He will have to measure shifts of less than one unit in order to get something significant. I am sure that Dr. Crowe appreciates that we shall have to get down to quantitative measurements. If you have a set with microphone, amplifier, resonator and telephone you can set up a control system and measure the number of sensation units going through the whole system.

DR. BRAY, Princeton: There is very little I can add to Dr. Crowe's presentation. Dr. Crowe's work may throw much light on the mechanics of the middle ear. At the present time we are working on a related problem, namely, whether we are dealing with a change in the sense organ or a change in the auditory nerve; whether we are picking out nerve impulses or sensory changes. Adrian has published a criticism of our work. He thinks we are dealing with sensory action and not with auditory nerve impulses. We think that perhaps Adrian is right, but perhaps we are also right. There may be both changes in the sense organ and in the auditory nerve impulse. We intend to carry on further experiments next year which will enable us to reach a conclusion on this problem. Whichever effect we are dealing with, Dr. Crowe's work is independent of that problem. A great deal more work along that line can be done which will throw light on the mechanism of the cochlea.

Presentation of an Instrument. Demonstration of Sounding Rods.

DR. ROBERT SONNENSCHN, Chicago: About fifteen months ago the late lamented Prof. Karl L. Schafer of Berlin described a sounding rod of the pitch of c-5 (4096 double vibrations) which he had perfected with Dr. Wethlow. This rod was held by a grip set in its exact center, and vibrated from 50 to 75 seconds. This was very desirable in view of the fact that the best steel forks vibrate only 20 to 30 seconds. In testing cases to determine whether there is a beginning change in the auditory nerve, it is highly essential to have a sounding body which will vibrate for a long period of time. I was able to persuade Dr. B. B. Eisenhower of the Riverbank Laboratory at Geneva, Ill., to make a similar rod, using the same aluminum magnesium alloy of which his forks are constructed. These rods vibrate from 50 to 90 seconds with a very clear tone. They are provided with a steel or brass grip set firmly in the exact center of the rod. Longitudinal vibrations are elicited by striking the rod on one of its ends with a rather hard pleximeter. He has also perfected a rod of the pitch of c-6 (8192 double vibrations), and this sounds for about 10 or 15 seconds, whereas forks of the same pitch usually do not vibrate more than five seconds. I believe these rods will prove of immense value in testing the higher tones, and since they are made of a magnesium alloy they are not only very light in weight but rust-proof.

MORNING SESSION, FRIDAY, JUNE 19, 1931.

BUSINESS MEETING. SCIENTIFIC SESSION.

Parotid Fistulæ in the Mastoid Wound.

DR. JAMES A. BABBITT,
PHILADELPHIA.

Review of literature, with scarcely twenty-five cases reported, shows similarity in origin, course and treatment. This paper simply adds another case with rather unique procedure in diagnosis. Study of case reports invites three premises for discussion: First, the occurrence of parotid fistula seems scarcely justified by the mastoid operative procedure alone. Second, in view of the important normal and abnormal relations to the operative field, the number of the fistula accidents is remarkably small. Third,

the efforts at repair have been varied and doubtless skillful but often unsuccessful.

The case reported, male, 74 years of age, came for examination because of slight oozing discharge from the tip of scar following mastoid operation a year and a half previously. The condition was not painful, but annoying and increased by movements of the jaw.

Patient had much nasopharyngeal pathology, was very deaf and in the course of X-ray studies, sodium iodide injection demonstrated fistulous communication with Stenson's duct. Silver, chromic acid, trichloroacetic and galvanocautery failed to close the opening. Under local anesthesia plastic procedure with moderate follow up proved successful.

Later the patient had mastoiditis on the opposite side. Both on account of patient's circulatory derangement and fear of fistulous repetition a modified attic drainage operation was substituted for mastoidectomy and proved successful.

The site of the fistula, the anatomic relations of the parotid, the plastic procedure in closure, X-ray demonstration of injected tract and Wakely's diagram for avulsion of the auriculotemporal nerve in unmanageable cases were shown by slides.

DISCUSSION.

DR. KARL KORNBLUM, Philadelphia (by invitation): In discussing Dr. Babbitt's presentation I would like to describe briefly the method employed in demonstrating the course and extent of the fistulous tract referred to by him. This consisted of visualization of the fistula by means of the roentgen ray after the injection of a radiopaque liquid.

This procedure calls for the closest co-operation between the otologist and roentgenologist. The injection must of necessity be made in the radiologic department, because it is essential that the injection be continued during the time of the roentgen exposure. For this reason everything must be in readiness for immediate exposure of the part at the time of the injection. To inject the fistula, Dr. Babbitt used a Luer syringe with a long probe-like needle. This was inserted into the small fistulous opening and with everything in readiness the injection was started.

When the patient indicated that the fluid was entering his mouth the roentgen exposure was made. During the exposure the injection was continued so as to secure a continuous and adequate distension and filling of the fistula.

During the past year there has been introduced into this country a radiopaque aqueous solution used intravenously for the purpose of visualization of the urinary tract. This substance is known as uroselectan and contains 42 per cent iodine. A more recent modification contains 51 per cent iodine. Because of its high iodine content it is quite opaque to the roentgen ray. Furthermore, it is nonirritating to the tissues, and for this reason is an excellent substitute for sodium iodide, which cannot be used much beyond a 20 to 25 per cent solution because of its irritant nature. Thus, for the visualization of a fistula such as described by Dr. Babbitt uroselectan would today be the opaque medium of choice.

This interesting case brings to your attention a method which will often prove valuable in determining the nature and course of fistulous tracts or chronic discharging sinuses, which are not infrequent in any type of surgical practice. While the method appears relatively simple, my own experience would indicate that attempts of this kind are more frequently unsuccessful than successful. There are various reasons for failure. In the first place, fistulae and sinuses often will not retain injected fluids. For this reason, roentgenograms must be made during the time of the injection. Furthermore, the small caliber of many fistulae, the numerous ramifications and the presence of retained secretions are all factors which may prevent a satisfactory injection. These causes of failures have been largely overcome by Dr. Paul Bishop of Philadelphia. Dr. Bishop passes an opaque ureteral catheter to the bottom or end of the sinus before injecting iodized oil. This passage of the catheter is often tedious and time consuming, but it is of extreme importance because the success of the method depends upon the ability to pass the catheter to the very end of the tract if this is at all possible. With the catheter in place the opaque medium is slowly injected. As it passes up alongside of the catheter the oil forces the secretions of the sinus outward to be discharged upon the skin surface. Such secretions, therefore, do not interfere with the injection.

DR. LOUIS K. GUGGENHEIM, St. Louis: As to treatment, in my case 15 per cent silver nitrate with a noncotton applicator was used and the fistula closed. It opened again later and was then treated with 50 per cent nitrate of silver. The fistula closed and never recurred. My associate, Dr. Ferris, had one case in a young woman of 19, which was healed with silver nitrate. It is interesting to read of the various methods applied. A number of the cases reported have never healed. Dr. Groves had a case of bilateral fistula which never closed. When one understands the anatomic situation, it is surprising that the lesion does not occur more frequently. The parotid gland sinks in deeply between the ramus of the jaw and mastoid, then sends a branch over to the sternomastoid muscle, from where it ascends to the tip of the mastoid. An incision carried down to or beyond the tip can easily injure the branch of the parotid.

A sketch was presented showing a sixteen-day embryo with its ectoderm, pharynx lined with entoderm and in between, mesenchyme. The entoderm grows out into the mesenchyme, dividing the latter into the branchial arches. The entoderm protrusions are the pharyngeal pouches. Externally ectoderm sinks in between the arches to form the branchial grooves. The pouches extend out to the grooves. The first pouch becomes the eustachian tube and tympanum; the first groove, the external auditory canal. If this pouch breaks through the ectoderm there results a branchial fistula. Such a fistula may develop anywhere about the external auditory canal and weep a salivary mucus or purulent material. If the branchial fistula connects up with the parotid gland a parotid branchial fistula may result. At six weeks the mouth of the embryo is quite wide and there is an ectodermal thickening at each corner. This ectodermal strand grows upward and backward toward the ear, finally becoming tubular and branching to form the parotid gland, and as the mouth grows smaller the duct reaches its adult position in the buccal mucosa.

DR. H. I. LILLIE, Rochester, Minn.: Two patients with parotid fistula were observed at the Mayo Clinic about ten years ago. The incision had been extended beyond the tip of the mastoid. Since that experience we have discontinued prolongation of the incision beyond the tip of the mastoid. The history in these two cases

was the same as those of Dr. Babbitt and Dr. Guggenheim. The application of the actual cautery clears up the situation in most instances.

DR. JACQUES HOLINGER, Chicago: I believe parotid fistula is of more frequent occurrence than we think. I know of one case in the child of a colleague—a lively child of four years. The parotid was swollen before the mastoid was operated upon. After the wound closed the parotid became fluctuating and had to be opened below the incision.

DR. BABBITT (closing): I am much interested in the embryologic possibility presented by Dr. Guggenheim. My own study left the impression that whether etiologically based on traumatism, embryology or faulty continuation and curve of incision, the fistulous discharge followed a sclerotic or adhesive disarrangement of the closely related extension of the parotid to the sternocleido-mastoid fibers.

Effect of Suppurative Disease of the Temporal Bone on Certain of the Cranial Nerves.

DR. HAROLD I. LILLIE,

MAYO CLINIC,

ROCHESTER, MINN.

Certain cranial nerves may be affected directly or indirectly by suppurative disease of the temporal bone. When a cranial nerve is affected it may be assumed to indicate that intracranial extension has taken place from the temporal bone. The problem of accurate anatomic and pathologic diagnosis is made more exacting under such circumstances. Stereoscopic visualization of the anatomic relation of the parts demonstrates that a lesion causing the symptoms need not be extensive. The lesion affecting the nerve may be due to congestion, to localized inflammation of the dura, to localized abscess formation, to diffuse serous or suppurative meningitis or to none of these causes. The lesion is most often situated in the petrous pyramid. The clinical picture as a whole must be given careful consideration. The fact that a cranial nerve is involved is not, I believe, sufficient evidence on which to institute radical surgical measures.

During the last few years many interesting articles have appeared in the literature which have dealt with the theoretic and practical application of present knowledge of the pathologic processes involving the petrous pyramid.

Profant, Eagleton, Kopetzky, Almour, Friesner and Druss have presented excellent articles on the clinical and pathologic aspects of the disease of the petrous pyramid.

Fifty-nine cases were observed in which the involvement of a cranial nerve or group of nerves was noted. Certain cases presenting involvement of the sixth, seventh and eighth nerves could be accounted for on the basis of disease of the petrous pyramid. The so-called Gradenigo syndrome was encountered in eleven cases. Involvement of individual branches of the fifth nerve, the second nerve and the jugular foramen syndrome were accounted for on some other basis. The seventh nerve was found involved in both acute and chronic suppurative otitis media and in association with the eighth nerve at the cerebellopontine angle. Labyrinthitis is not dealt with for obvious reasons. The jugular foramen syndrome was encountered in a patient who developed a lateral pharyngeal abscess.

The natural inference under such circumstances is that the disease of the mastoid is of a more serious nature than usual. The fact that a cranial nerve is involved is of unusual significance and therefore the clinical picture as a whole must be considered carefully in order that well directed treatment may be instituted.

DISCUSSION.

DR. JOHN R. PAGE, New York: Dr. Lillie's statements that the lesion in these complications is most often situated in the petrous pyramid may be warranted by the reports published, but it is not by the cases that have come under my care, not even the cases of sixth nerve paralysis, if lesion in the petrous pyramid refers to the petrous apex.

In four of these that I particularly recall it is interesting to note, in view of the association of the sixth nerve paralysis with involvement of the Gasserian ganglion and suppuration at the petrous apex, none could be attributed to that origin. All were associated with a blood stream infection that involved the inferior

petrosal sinus. One of these cases was reported in 1910, but I have seen no mention of them elsewhere.

In the four cases I refer to, all showed signs of blood stream infection, and three were operated on for sinus thrombosis. While no involvement of the sigmoid sinus was found, there was no bleeding from the jugular bulb in any one of the three. The paralysis was attributed to edema around the overlying nerve from thrombosis of the bulb and the inferior petrosal sinus. This diagnosis was supported by evidence of blood stream infection and the absence of signs typical of the Gradenigo syndrome. Otherwise, it might be argued that involvement of the inferior petrosal sinus and jugular bulb occurred as a result of suppuration at the petrous apex.

Sixth nerve paralysis, because of its dangerous significance, is probably more disturbing to the otologist than to the patient. But it does not necessarily mean involvement of the bone at the petrous apex, and if the inflammation in the tympanum and mastoid, the pain and fever are subsiding, I agree with Dr. Lillie that the palsy alone does not demand operation.

DR. SAMUEL J. KOPETZKY, New York: In regard to the quiescent stage of the disease, Sir Charles Ballance gave us a very significant observation in his discussion yesterday which is of moment to our problem here. We have not been in the habit of keeping the patient, while in the ambulatory stage, under sufficient control and observation. One case, an ambulant patient, twice reported having periods of photophobia; another had transient nystagmus and periods of vomiting. By the time the case is visited, or comes to the office, or you bring a colleague into consultation the symptoms have passed. Hence I was much impressed with what Sir Charles recommended, namely, that cases of neurologic import should have examinations and findings noted morning and evening. In this way, one is less likely to miss the transient signs coming from the adjacently lying intracranial nerves.

DR. WELLS P. EAGLETON, Newark: The whole proposition hinges not on whether a man has a mastoid—of course he has a mastoid—but it depends on the question whether, after you have exenterated the mastoid, the symptoms continue. The sixth nerve

has a peculiar course. It goes through Borello's canal to the opening of the dura.

DR. KENNEDY: I think we should also take into consideration the fact that cranial nerves may become involved during a mastoid disease, but from conditions dissociated with mastoid disease. I have made observations on the syndrome of Ramsey Hunt, which is a separate disease entity, perhaps a herpetic disease of the Gasserian and geniculate ganglion. Then there is Fovell's syndrome with the appearance of paralysis of the third, fourth, sixth and seventh nerves of the same side with hemiplegia of the opposite side. This syndrome was recently seen in an aged person. Casual observation did not at first show hemiplegia of the opposite side. It was accidental that the patient developed a lesion in the pons.

DR. H. I. LILLIE (closing): The point Dr. Page makes is well taken. Thrombosis of the jugular bulb probably extends up the inferior petrosal sinus and the inflammatory reaction can affect the apex. Neuro-surgeons have known for some time that palsy of the sixth nerve is not of particular diagnostic significance. Cushing, in 1909, said it is not very significant. It depends on whether the artery is over or under a nerve. It might be in either place. In discussing this with Dr. Peet he told us he relied more on homolateral dilatation of the pupil than on palsy of the sixth nerve. I am grateful to Dr. Eagleton for supplying the details which I left out. In regard to recovery, as Dr. Kopetzky said, there are certain things about the look of the patient that are significant. The patient may not complain, he may not be the type that complains, but if he does not "snap out of it," there is cause for concern. This apparent freedom from symptoms is not reliable. I have seen patients who apparently were almost well and suddenly found them almost in extremis. I had a patient several years ago with suppurative labyrinthitis. A labyrinth operation was performed, and the patient did well for four weeks. He was in an automobile accident and received a fracture of the apex. Every clinical sign of diffuse suppurative meningitis was present, but the spinal fluid was normal. This seemed paradoxical. The patient died and at necropsy it was found that the magendic foramen was completely closed off by exudate and this

did not permit the circulation of the cerebrospinal fluid. In conclusion, I would say that if the patient has low grade sepsis with sweating, lack of appetite and lack of "pep," he should be carefully watched and the possibility of inflammation of the petrous pyramid thought of as a causative factor.

The Biologic Development of the Cerebellum.

DR. WELLS P. EAGLETON, Newark: This presentation of mine today is a continuation of a study made years ago on the relation of the apparatus to the central nervous system and the evolution of life.

In the invertebrate there is an otocyst which gradually develops into a very complicated mechanism. In fishes it becomes an otolith which regulates the body movements. Mechanically the stone has to have greater weight than the fish. This explains how the size of the labyrinth in all animals bears a definite relation to the size of the animal. I have then endeavored to show that as life came out of the water, the otolith became of less importance and degenerated, until in man it is merely a microscopic and vestigial structure.

In the vertebrate a new mechanism is added, the semicircular canal, which is entirely beyond the invertebrate. Phylogenetically Scarpa's ganglion is lower in development than the spinal ganglia. The latter indicate a development process during life which the vestibular ganglia do not.

In animals the cerebellum developed from the place where the neuroganglia of the vestibular apparatus and the semicircular canals are formed. In land animals, the cerebellum progressed, with contraction of the part of the brain called the midbrain. With the development of the hemisphere man obtained the upright position.

The retinal eye is surrounded by a mechanism with attached nerves which govern its movements. The added nervous mechanism of the eye is attached to the vestibular apparatus, which is the underlying basis of equilibrium. This apparatus creates nystagmus. It is a central mechanism in the brain itself, running from a definite place to a definite place.

Nystagmus is present in all animals that have movable eyes. The reflex is designed to return the eyes to normal position of equilibrium.

I want you to bear in mind that the vestibular mechanism is a very low mechanism. It has tracts, but they are associated tracts. When you test the vestibular apparatus you test a low mechanism.

I wish to emphasize the importance of turning all cases that come to us for observation.

In regard to the ethmoid, when there is involvement of the ethmoid there is always tenderness over the eye on pressure.

THE WORK OF THE AMERICAN FEDERATION OF THE ORGANIZATIONS FOR THE HARD OF HEARING, INC.

A. Social Aspects.

MISS BETTY C. WRIGHT, EX. SEC.,

WASHINGTON, D. C.

(By invitation.)

The American Federation of Organizations for the Hard of Hearing was formed by Dr. Wendell C. Phillips of New York. Its three great aims are the rehabilitation of the deafened, the conservation of hearing and the prevention of deafness. These aims are carried out by organizing leagues for the hard of hearing; promoting the efficiency of existing leagues with respect to lip reading, the use of hearing aids, employment; social rehabilitation, eradication of quackery; by promoting hearing tests for school children and medical research on the causes, treatment and prevention of deafness. In 1919, there were nine organizations for the hard of hearing. Today there are 107. Its individual membership has increased from nineteen to twenty-five hundred.

The federation has investigated the best methods of testing the hearing of school children and hastened the development of the 4-A audiometer; established a magazine, the Auditory Outlook, which keeps its members informed about developments in the fight against deafness; has given vocational advice to hundreds of people; and has sent field workers to 141 cities. Through its information service at headquarters it answers queries concerning hearing tests, lip reading for adults and children, quack cures for deafness, reliable hearing aids, development

of organized work for the hard of hearing. The Everywhere League, a correspondence club for the hard of hearing, keeps the isolated deafened in touch with each other by means of round robins or ring letters. The members of this league are scattered all over the United States and Canada, and there are also members in Australia, Cuba, England, Greece, Holland, Russia, Switzerland and Wales.

The federation believes that the greatest single factor in the process of rehabilitation is lip reading, "the art of understanding a speaker's thought by watching the movements of his lips." A person with acquired deafness and all of its accompanying limitations, regains his self respect with the acquisition of this art, no matter in what degree, and his former attitude of listlessness and indifference gives way to alertness and interest.

Many otologists have co-operated in the work of the federation and have served and are serving as officers and members of the Board of Managers of the federation; they are also serving in active and advisory capacities in local leagues. These otologists realize that the leagues are of service to them and are in reality hope filling stations for their patients who can never again have normal hearing.

It is hoped that the American Otological Society will take the necessary steps to insure the inclusion, in all courses of otology, of lecture, reading and observation courses in the psychology of deafness and social work for the hard of hearing.

The selection of secretarial assistants is of utmost importance. In addition to queries concerning the efficiency of an applicant as a secretary and general office manager, it is suggested that the following questions be added:

Have you ever come in contact with a hard of hearing person?

How do you feel toward them?

Do they irritate you?

Do you feel that they are inferior mentally because they are hard of hearing?

How would you treat a person who comes to the office for advice?

If he did not understand you, how would you put him at ease?

What would you do if he resented being spoken to in a loud tone?

How could you make him inconspicuous if he seemed shy?

How would you announce to the hard of hearing patient that the doctor is ready?

Do you know what lip reading is?

When is it impossible for people to read the lips?

How can you help a lip reader or a person who is using a hearing aid?

Everyone who is employed in an otologist's office, in an ear clinic, in organization work for the hard of hearing, should know how to deal with hard of hearing people. We have a right to expect courtesy and consideration in the places we naturally turn to for help with the problem caused by our deafness. I believe it would be valuable for local otologic societies to arrange for round tables for the secretaries of their members and the workers in the local leagues for the hard of hearing.

B. Scientific Aspects.

DR. EDMUND P. FOWLER, New York: The New York League for the Hard of Hearing should be credited with pioneer efforts in the scientific approach to the problem of prevention of deafness along certain lines. The members are requested to answer questionnaires on deafness and to submit a brief personal history and to obtain an audiometric examination of their hearing.

The phonograph audiometer was constructed at the instigation of the league for the survey of the hearing of school children. These surveys show approximately 3,000,000 deafened school children in the United States.

I determined in several schools of over 1,000 pupils that only one-quarter of the children who were deafened realized their disability, so that it is logical to believe that many times this number of adults must also be deafened without realizing their condition. I believe surveys should be made of large selected and unselected groups of adults in colleges, general hospitals, insurance applicants, life extension institutes, etc.

We are carrying on surveys in a general hospital and have made a careful examination of one large hospital for the tuber-

culous. These activities will accomplish little unless something can be done for those who are found potentially or actually deafened.

The ordinary otologic clinic gives little or scant attention to deafness, as its energies are expended mainly upon surgical cases, and so we established at the Manhattan Eye, Ear, Nose and Throat Hospital a service especially for the children found deafened by the league's school hearing surveys. It was thought, beside the immediate benefits, this might stimulate or initiate further efforts along the same lines (the care and study of the diseases causing deafness). There have been established to date six such clinics.

Statistics of attendance at the clinics were given and details of scientific and clinical laboratory work, the latter being carried out mainly upon autopsy material obtained at the Medical Center Group of Hospitals, New York City, and from animals in the pathologic research laboratories at the College of Physicians and Surgeons.

Several of the author's own devices and diagnostic treatment technics are described and his method of determining and recording the fundamental data and tests. The stereoscopic roentgenograms of the temporal bones, nasal sinuses, chest, etc. Also the blood chemistry, tuberculin and Wassermann reactions are gone into and some interesting data obtained by examining many members of the same families. This paper was profusely illustrated by lantern slides and supplemented in the discussion by dissertations upon roentgenographic pictures by Dr. Law and the laboratory tests for sinus pathology by Dr. Eggstrom. The correlation between the clinical picture and pathology, as shown by roentgenograms and the tissues removed by operation, was particularly stressed. These studies account for the otherwise inexplicable discrepancies between the clinical and X-ray pictures of sinus and mastoid disease.

Results concerning experimental work was also mentioned and details given of the method of tabulating cases under the disease and age groups. Home treatment was especially stressed, and also the fact that otosclerosis frequently exists unsuspected and without causing any deafness, and that therefore in supposedly

normal people we may discover the cause of certain types of deafness as otosclerosis.

The necessity of co-operation between the leagues for the hard of hearing and the otologists is again and again stressed. The hope is expressed that many otologists would attack the problem of deafness from the research standpoint in their clinics and in their practices.

DISCUSSION.

DR. D. HAROLD WALKER, New York: We have here the first president of the American Federation for the Hard of Hearing. He was the first to realize that this work had to be done and has done more than anyone else to advance it.

DR. WENDELL C. PHILLIPS, New York: I feel that words are unnecessary from me, after listening to the remarkable and comprehensive presentation of Miss Betty Wright. Any remarks I might make would be only an elaboration. I might mention one or two points covered by me in a paper recently presented at the national convention of the federation. The first is how to get otologists to advise patients who are moderately hard of hearing to study lip reading. Some are apt to advise against it, and that one fact is constantly hampering teachers of lip reading. There seems to be an impression in the minds of some otologists that if children learn lip reading they will lessen their effort to hear.

MISS PECK, New York: I have been asked to say a few words of the work which I am engaged in. At first it was a work that no one wanted to do, and later we felt that no one else could do the work we did. Your profession was the first to recognize our efforts, and now we should like to know what we can do for you. We can do a lot for the patients, and I think that one thing we can do for you is to build up a better attitude in the patient. We can prevent the patient's becoming discouraged. The otologist has all the time to wrestle with this attitude in the patients. Miss Wright has said that she would like to build up a better attitude on the part of the otologist and of his secretary. I would like to publish the banns of matrimony between the scientific side of the work, presented by Dr. Fowler, and the social side of the work, presented by Miss Wright. Our social work must be founded on a scientific basis. There must be a clinic for diseases of

the ear, and there must also be an educational clinic for studying the problems of the deaf. These include speech and voice training. Our work should not be just to get people together for a long time, but should be planned for mental hygiene. The publicity given to hearing aids must be supervised by science in order to prevent quackery. You, as otologists, know that there is no universal aid to hearing, and you must guide us in selecting the proper aid for differing conditions. On the other hand, our league can be useful to scientific men; it can act as a sort of research bureau to investigate the many sided problems of this big problem. In questions of psychiatry and public health, of marriage and heredity, we can help you with our observations. We have thus become an organization of enthusiasts and we shall look forward to becoming more and more of scientific service.

DR. HARVEY FLETCHER, New York (by invitation): I do not know that my words can add anything to the case of the federation versus the otologist, as presented here this morning. I think all human beings have somewhat the same feelings, and if you had the same feeling that I did while listening to Miss Wright and Miss Peck here this morning, then in the future you will all lend more encouragement to the work that the federation is doing in this country than in the past. It means a lot in the lives of these people. I do not think you realize what your indorsement of the work means to them; I do not think you realize what a word of discouragement means to this work if it is uttered by an otologist of standing in his community, and I would beg you to be careful how you criticise. These people have carried such wonderful enthusiasm into their work that they are capable of doing a great service. Any word coming from you they take with due respect to scientific training.

MISS WRIGHT (closing): I have nothing to add except to again express my appreciation of the interest shown here this morning. I hope we can continue to expect your co-operation to an even higher degree in the future.

DR. F. M. LAW, New York: I want to occupy a few moments in explaining to you the method in detail which we use to interpret the films belonging to those cases in which we find profound changes in the audiometric charts. In the past interpretation has

been based on occlusion of the cells, but many cells do not show this; they appear perfectly clear. A number of years ago we found changes in the bony structure of the bony septum in conjunction with laboratory and operative findings. We found that often the X-ray interpretations corresponded with the laboratory report.

DR. EGGSTROM, New York: As a result of the study of pathologic foci in this work, also in relation to the work in eye clinics, and in examination of the teeth, we have tried to bring order out of chaos in the classification of changes which occur in the sinus, and in this way we have come to a better understanding of the changes which occur in chronic sinusitis. There are three types of lesions: (1) Hypertrophic type, due to obstruction of the lymphatic and venous channels. A normal amount of blood reaches the part, but is not drained away and we get edema of the tissues and polypoid growth. These obstructions may be localized or may be over a large area. There may be periphlebitis and perilymphangitis. (2) It is difficult to diagnose when the membranes become thin and there is increase of fibrous tissue resulting from arteritis. The nourishment of the part is insufficient and you get the fibrous or atrophic type which may go on to ozena. (3) This is the combined type. The antrum looks pulpy, with areas of polyps and atrophy and thinning of the mucous membrane. When chronic sinusitis follows acute sinusitis, the changes are due to repeated injuries to the mucous membrane. The acute changes are perivascular in nature.

CONTENTS—Continued from Second Cover Page.

XL.—Fracture of the Larynx with Report of a Case. Claude T. Uren, M. D., Omaha	513
XLI.—Adenoids and Upper Respiratory Disease (Common Cold) in Adults. William M. Gafafer, Sc. D., Baltimore	517
XLII.—Deafness, Hepatic Dysfunction, Pancreatic Insufficiency: A Clinical Entity. Mark J. Gottlieb, M. D., New York	523
XLIII.—Pulmonary Abscess Following Tonsillectomy. Ira Frank, M. D., Chicago	550
XLIV.—Brain Abscess with Peculiar Bacteriologic Findings. W. E. Grove, M. D., Milwaukee	555
XLV.—Mixed Tumor of the Nasal Septum. Holland N. Stevenson, M. D., New Rochelle, N. Y.	563
XLVI.—The Treatment of Automobile Accident Cases Where the Nose and Face Are Involved. William Wesley Carter, M. D., New York	571
XLVII.—A Method for the Control of Postnasal Hemorrhage. James Beavis, M. D., Ann Arbor	576
XLVIII.—Otomycosis: A Clinical Consideration. Walter J. Bristow, M. D., Columbia, S. C.	578
Clinical Notes	584
XLIX.—Sinus Thrombosis with Unusual Complications. Harold Hays, M. D., New York	584
L.—Two Cases of Surgical Mastoiditis with Unusual Complications, Including Repeated Rupture of the Lateral Sinus: Recovery. Virginus Dabney, M. D., Washington	593
LI.—Traumatic Pneucephalon. Richmond McKinney, M. D., Memphis, Tenn.	597
LII.—Five Nasal Tumors. Eugene R. Lewis, M. D., Los Angeles	601
Notices	611
Second International Congress of Otolaryngology and Rhinology	611
American Board of Otolaryngology	611
Abstracts of Current Articles	612
Society Proceedings	626
Abstract of Transactions of the American Otological Society (Continued from the March issue.) Meeting held on Thursday, June 18, 1931. Function of the Tensor Tympani Muscle (Experimental Study).—Presentation of an Instrument: Demonstration of Sounding Rods.—Parotid Fistulae in the Mastoid Wound.—Effect of Suppurative Disease of the Temporal Bone on Certain of the Cranial Nerves.—The Biologic Development of the Cerebellum.—The Work of the American Federation of the Organizations for the Hard of Hearing, Inc.: A. Social Aspects.—B. Scientific Aspects ...	